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PHYSICS ABSTRACTS

SECTION A

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SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

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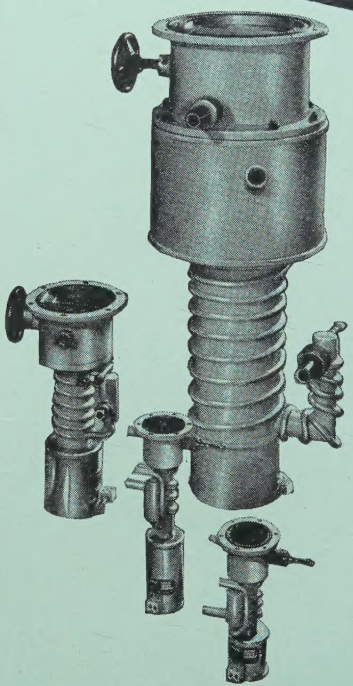
ABSTRACTS 9876–10712

VOLUME 57 **NOVEMBER 1954** NUMBER 683

The WHEN? and WHY? of MERCURY VAPOUR PUMPS



These examples are but a few of the many specific applications of mercury vapour pumps which we manufacture to meet every research and industrial requirement—complete, if necessary, with valves, traps, backing pumps and lines and all accessories.

A new addition to our range is the MODEL 2M4, a very high backing pressure pump, which can be isolated from the backing line for long periods without loss of pumping speed.

ULTIMATE VACUUM: 10^{-6} mm.Hg.

When?	*Why?*
PUMPING AGAINST VERY HIGH BACKING PRESSURES	Achieves high boiler pressures without fluid decomposition.
GAS "SAMPLING"	No decomposition products of the fluid to mingle with sample gas.
MAKING RHODIUM MIRRORS BY VACUUM EVAPORATION	This metal is extremely sensitive to oil vapour which causes discolouring.
EVACUATING SYSTEMS CONTAINING PHOTO-SENSITIVE OR SECONDARY-EMISSION SURFACES	The mercury pump combined with the liquid air trap keeps system entirely free from contaminants.
EVACUATING MERCURY ARC, MERCURY VAPOUR LAMPS, ETC.	Mercury is already in system. No liquid air trap is necessary.
PUMPING CHEMICAL GASES AND VAPOURS	Many chemical gases will attack organic fluids.
PRODUCTION PUMPING OF MINIATURE RECEIVER VALVES	Ability to withstand rough usage on ultra-quick production cycles.

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Electronic relays and counters
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Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 56 (1953) and the Supplement published with the Index to Volume 56 (1953). Reprints of the List of Journals (1953) and the Supplement (1953) can be obtained from the Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. 0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

New York Univ. Inst. Math. Sci. — *New York University, Institute of Mathematical Science, Division of Electromagnetic Research.* 25 Waverly Place, New York 3, N.Y.

Trans Instrum. Meas. Conf. — *Transactions of the Instruments and Measurements Conference, Stockholm.* The Royal Swedish Academy of Engineering Sciences, Box 5073, Stockholm 5, Sweden.

New Journal

J. nuclear Energy — *Journal of Nuclear Energy.* Pergamon Press, Maxwell House, Marylebone Road, London, N.W.1. Quarterly. Volume 1, Number 1, dated August, 1954. Subscription per volume: (A) £4 10s. 0d. (U.S.A. $12.60), including postage; (B) for individual subscribers certifying that the journal is for their private use, £3 10s. 0d. (U.S.A. $9.80), including postage.

Errata

p. 565, column 1, line 27: *for* **emission** *read* **emulsion.**
Abstr. 528 (1954), line 2: *for* H. P. KLEPIKOV *read* N. P. KLEPIKOV.
Abstr. 2481 (1954), line 3: *for* (*July*, 1952) *read* No. 4–6 (1953).
Abstr. 2482 (1954), line 3: *for* (*July*, 1953) *read* No. 4–6 (1953).
Abstr. 8170 (1954), line 2: *for* C. F. POLLNOW *read* G. F. POLLNOW.
Abstr. 8396 (1954), line 4: *for* auto-coincidence *read* anti-coincidence.
Abstr. 8721 (1954), line 15: *for* a friction force independent *read* friction force is independent.
Abstr. 9353 (1954), line 3: delete initial before RAMA.
Abstr. 9354 (1954), line 2: delete initial before RAMA.
Corrections to articles—(*June* 1954) Abstr. 3928 (1954): *for* **22,** 766 (*April*, 1954) *read* **22,** 765 (*April*, 1954).

MATHEMATICS 51

517.63

9876. The Laplace-transformation and its application. P. FUNK, H. SAGEN AND F. SELIG. *Wien: Franz Deuticke* (1953), 106 *pp. In German.*

This book begins with a statement of the properties of Laplace transforms and their applications to the solution of systems of differential equations with constant coefficients. Application is then made to (1) the theory of the electrical transformer, (2) Abel's integral equation, (3) the heat equation, (4) electrical cables. Fourier's integral theorem and the general inversion formula are discussed together with asymptotic developments. The theory of regulating devices is considered in some detail, especially the question of stability. L. S. GODDARD

518.5 : 621.317.39

9877. A curve analyzer and general purpose graphical computer. C. S. FRENCH, G. H. TOWNER, D. R. BELLIS, R. M. COOK, W. R. FAIR AND W. W. HOLT. *Rev. sci. Instrum.*, **25**, 765–75 (*Aug.*, 1954).

A graphical computer based upon five automatic curve followers, two integrators, nine adding amplifiers, and a pen recorder was built for the transformation and combination of curves and for a simple analogue computer to plot curves from equations. Heavily inked curves on 14 in. × 17 in. moving tables are tracked by photoelectric followers which continuously set potentiometers so that their output voltage is proportional to the curve height. The tables are positioned by voltages so that they may be made to move at a constant rate or may be individually controlled by some variable voltage. The follower output voltages may be transformed in various ways or combined algebraically with each other and used directly or indirectly through amplifiers to drive a recorder, a table or an integrator. By this means curves may be changed in scale (linearly or non-linearly) on either axis. Curves may be added, subtracted, multiplied, divided, or otherwise combined or operated upon in accordance with simple equations, and the result plotted in about a minute with an accuracy under favourable conditions of about ± 0·02 in. Complex curves can be analysed by fitting with algebraic combinations of simpler curves. The apparatus may be used to fit integral or differential equations to experimental data by trial adjustment of the constants. A low a.c. voltage increasing linearly with time represents the independent variable; the form of the equation is determined by the way in which the various units are connected and the values of constants are set by potentiometers. A.

518.5 : 621.317.79

9878. A one-dimensional Fourier analog computer. L. V. AZAROFF. *Rev. sci. Instrum.*, **25**, 471–7 (*May*, 1954).

A computer has been constructed to sum Fourier series having up to 30 terms. Although this is a one-dimensional computer it can be used for double and triple summations by using standard trigonometric expansions. ODFAC sums $\Sigma_n F_n \sin/\cos 2\pi nx$ electrically. The trigonometric function is produced by a variable-angle transformer known as a resolver. Each amplitude is set by a variac which regulates the input to a particular resolver. The frequencies $2\pi nx$ for 31 values of n are arranged by gearing the rotors of the resolvers in ratios 0, 1, 2, . . . 30. The resultant individual currents are added in parallel and the value at point x (in intervals of 1/60, 1/120 or 1/240 of a cell edge) is read on a voltmeter and the phase is read on an oscilloscope. The relative speed of a computation is five to ten times faster than the standard strip methods. The average error in a computation compares favourably with the rounding-off error in conventional two-place strips. A.

518.5 : 621.317.79

9879. Partial drift compensation in electronic d.c. analog computers for differential equations. L. E. LÖFGREN. *Appl. sci. Res. B*, **4**, *No.* 1–2, 109–23 (1954).

The most serious errors in electronic d.c. analogue computers for differential equations arise from drifts due to unbalances in the amplifiers. A method of reducing these errors by partial drift compensation is described. The analogue computer as a whole is compensated for certain drifts in the way they appear in the differential equation. The sources of one drift may be located in several elements of the computer. The number of points where the compensation has to be applied is usually much smaller than the number of sources. Thus the partial compensation is an economic solution of the drift problem if it can be realized. This question is treated, and it is shown that this kind of compensation is well suited for analogue computers with time-shared elements. An example is given where the number of compensation points is 9, although the number of drift sources is 45. A.

518.5 : 621.374.32

9880. An arithmetic unit for automatic digital computers. J. R. STOCK. Note in *Z. angew. Math. Phys.*, **5**, *No.* 2, 168–72 (1954).

The general arithmetic design of the new computer at the Swiss Federal Institute of Technology is briefly outlined. It contains 3 circulating registers, each holding a 15-digit word, and is in general conventional except that the exponents are not handled in separate registers from the mantissas but in the same ones at different times. The number of repeated additions is not controlled by a counter but the digit itself is reduced by one at each addition, and similarly for shifting operations. Average computing times are 5 msec for addition and 30 msec for division.

A. J. KENNEDY

519.2

9881. Determination of an acceptance region for sampling inspection on the basis of [arithmetic] mean and range. Z. KOUTSKY AND L. PROUZA. *Slaboproudý Obzor*, **14**, *No.* 10, 441–4 (1953) *In Czech.*

A method of setting up an acceptance region consisting of a parabola and two straight lines is briefly

described. This is based on the average and range (difference between the highest and the lowest values) of the measured parameters of a sample, both these quantities being easily computed. A normal distribution of population in the sampled batch is assumed. For the case of samples consisting of four pieces, a number of operational characteristics giving the probability of acceptance in terms of the rejection rate are plotted for various sampling procedures. It is thought that the method is particularly suitable for the inspection of the products of telecommunication industry. R. S. SIDOROWICZ

519.2

9882. On periods of rejection of random functions. P. I. KUZNETSOV, P. L. STRATONOVICH AND V. I. TIKHONOV. *Zh. tekh. Fiz.*, **24**, *No.* 1, 103–12 (1954) *In Russian.*

The "periods of rejection" are those intervals of a variable t for which a random function $\xi(t)$ exceeds a fixed function $\phi(t)$. The probability distribution of lengths of such intervals is obtained under fairly general conditions. The solution depends on the joint distributions of $\xi(t_1), \ldots \xi(t_k)$; $\xi'(t_1), \ldots \xi'(t_k)$ for general sets $t_1, \ldots t_k$. An expression, in the form of a series expansion, is obtained for such joint distributions, based on the "quasi-moments." Special cases of the general solution include the well-known Poisson process. N. L. JOHNSON

ASTRONOMY . ASTROPHYSICS . GEODESY 52

523.112 : 530.12

9883. The age of the universe in the cosmology of general relativity. G. C. MCVITTIE. *Astron. J.*, **58**, 129–34 (*July*, 1953).

For homogeneous expanding space-times $ds^2 = dt^2 - R^2(t)\, d\sigma^2/c^2(1 + kr^2/4)^2$ the reciprocal Hubble constant can be interpreted as the age of the universe only if $R(t) \propto t$, other assumptions for $R(t)$ leading to different but equally plausible ages. If $R(t)$ is a linear, exponential or hyperbolic sine function, Einstein's field equations imply that density and pressure are not always of the same sign, although $\rho + 3p/c^2$ is constant in all three cases and the model universes involve the conversion of stress into mass. R. A. NEWING

523.12 : 539.17

Equilibrium mixture of nuclei in an electron gas. *See Abstr.* 10484

523.121

9884. Some cosmological considerations in connection with the problem of the origin of the elements. O. KLEIN. *Mem. Soc. Roy. Sci. Liège*, **14**, *Special No.*, 42–51 (1954).

The supergalactic system is tentatively regarded as an ordinary but very large superstellar system which has condensed from a thin cold hydrogen cloud. With suitable assumptions concerning the early state and development of the system, ordinary physical laws would provide a basis for Eddington's relations $R/k \propto e^2/\gamma m_e m_p \propto \sqrt{N}$. R. A. NEWING

523.121

9885. On the origin of stars. V. A. AMBARTSUMIAN. *Mem. Soc. Roy. Sci. Liège*, **14**, *Special No.*, 293–300 (1954).

Considerations of stellar associations suggest that stars may have originated in groups. The question of such formation from a dense protostar is discussed in general terms. R. A. NEWING

523.121

9886. On the formation of protogalaxies in the turbulent primordial gas. G. GAMOW. *Proc. Nat. Acad. Sci. U.S.A.*, **40**, 480–4 (*June*, 1954).

The application of Jeans' formula for gravitational instability requires large density fluctuations that could be provided only by turbulent motion. The present distribution of galaxies in space may be regarded as "fossilized turbulence" and used to estimate the nature of the initial turbulent motion. It is concluded that initial turbulence must have been supersonic with Mach numbers of the order of 30. R. A. NEWING

523.165

9887. On the interpretation of the extragalactic radio-frequency radiation. W. PRIESTER. *Z. Astrophys.*, **34**, *No.* 4, 283–94 (1954) *In German.*

The isotropic component of the observed radio-frequency radiation cannot be explained, on any plausible world model, as emission from normal galaxies. Estimates of the number of pairs of colliding galaxies are made, using Hubble's statistics, and it is shown that the observed radiation can be explained if each colliding pair emits an average of 10^{25} watts per steradian per unit frequency range at 100 Mc/s, which is 1/25 of the observed emission of the Cygnus-A source. If recent observations, suggesting that Hubble's counts are too small, are confirmed, then a substantially smaller mean emission suffices. M. W. OVENDEN

523.165

9888. On the number of radio stars in the Milky Way. W. PRIESTER. *Z. Astrophys.*, **34**, *No.* 4, 295–301 (1954) *In German.*

A comparison of the total emission of the Milky Way in the radio-frequency range with the number and apparent radio brightnesses of the observed radio stars leads to an estimated total number of such radio stars in the galaxy of 2×10^{11}. This high frequency suggests that radio stars may be treated as normal stars which are feeble emitters in the visual range. An average emission of 10^9 watts per steradian per unit frequency range and a density in the solar neighbourhood of 7×10^{-2} per cubic parsec are deduced. The energy in the range 10 to 3000 Mc/s is about 1/8000 of the bolometric energy. M. W. OVENDEN

523.2

9889. On the origin of the solar system. H. ALFVEN. *Oxford: Clarendon Press* (1954).

Review in *Phil. Mag.*, **45**, 996 (*Sept.*, 1954).

523.53

9890. Determination with the aid of radar of the heights and radiants of the meteors of a shower. D. W. R. McKinley. *C.R. Acad. Sci.* [*Paris*], **238,** 2224–5 (*June* 9, 1954) *In French.*

The general technique indicated by Volmer [Abstr. 1970 (1954)] has been used to make a statistical separation of meteors of a shower from sporadic meteors and meteors of adjacent showers. Compared with the variation of mean height of disappearance of a meteor train with meteor velocity, the variation of the minimum height of disappearance with radiant altitude is a second order effect; it may be due to the increasing statistical significance of large meteors (which penetrate below the ionosphere whatever the inclinations of their paths) as the radiant rises.

M. W. OVENDEN

523.72

9891. The emission polar diagram of the radio-frequency radiation from sunspots. K. E. Machin and P. A. O'Brien. *Phil. Mag.*, **45,** 973–9 (*Sept.*, 1954).

A statistical analysis of daily measurements of the intensity of radio emission from the sun over a number of years has led to a determination of the variation in sunspot emission caused by the solar rotation. The total widths to half intensity of the emission polar diagrams derived in this way for an average sunspot are 15°, 20° and 36° for frequencies of 81·5, 175 and 500 Mc/s respectively. The analysis also suggests that there is a decrease in the life-time of the sources of radio emission as the frequency decreases; the life-time at 175 Mc/s is comparable with that of a visible spot. A.

523.851.2

9892. A survey of present knowledge of globular clusters and its significance for stellar evolution. A. R. Sandage. *Mem. Soc. Roy. Sci. Liège,* **14,** *Special No.*, 254–74 (1954).

Colour-magnitude diagrams and luminosity functions are used to construct semi-empirical evolutionary tracks for stars of a cluster, it being assumed that a star follows the Schönberg–Chandrasekhar tracks until its isothermal core attains the limiting mass. R. A. NEWING

523.852.22

9893. Physical and galactic characteristics of planetary nebulae. H. M. Johnson. Note in *Astrophys. J.*, **120,** 182–4 (*July*, 1954).

Discusses an apparent correlation between the degree of excitation, the temperature of the central star of a planetary, its galactic z-distance and peculiar velocity, v_{rp}. The degree of excitation is best measured by the ratio of emission intensities of the N_2 (O III 4959), and Hβ lines, viz. m_{N_2}. Based on data for 36 nebulae a significant correlation of z with m_{N_2} is found, and a corresponding increase of v_{rp} with this same parameter supports its reality. Moreover, these increases do not depend on a systematic change in the distance of the planetary from the sun. The ratio, m_{N_2}, is too large, viz. around $-1{\cdot}0$, to be explained by interstellar reddening, or by collisional excitation near the galactic plane. D. R. BARBER

523.855

9894. Fluctuations in the space distribution of the galaxies. V. C. Rubin. *Proc. Nat. Acad. Sci. U.S.A.*, **40,** 541–9 (*July*, 1954).

The space distribution of the galaxies may be analysed adequately in terms of a fluctuating density field, using methods based on the physical theory of turbulence. This has two advantages: it requires a minimum number of parameters, and conforms to the idea of the galaxies having condensed initially from a turbulent gas. The upper limit to the microscale of the turbulence is $\sim 10^7$ parsecs, i.e. of the order of the dimensions of clusters of galaxies. D. R. BARBER

523.877

9895. Stability of higher modes for stellar models under variable Γ. R. S. Kushwaha. *Proc. Nat. Acad. Sci. India A*, **20,** *Pt V*, 229–38 (1951).

523.877

9896. The chemical composition of white dwarfs. E. J. Öpik. *Mem. Soc. Roy. Sci. Liège,* **14,** *Special No.*, 131–8 (1954).

Considerations of nuclear reactions in contracting stars devoid of H, and of estimated ages, suggest that the composition is mainly of heavy elements of average atomic weight about 25. R. A. NEWING

523.877

9897. Abstract of some papers published in USSR concerning the internal structure of stars and their stability. V. Kourganoff. *Mem. Soc. Roy. Sci. Liège,* **14,** *Special No.*, 153–62 (1954) *In French.*

A detailed review of V. S. Sorokine's *Researches on the equilibrium of isothermal gaseous spheres* [*Astron. J. USSR*, **29,** 25 (1952)] which is concerned with a partially degenerate gas composed of free electrons and α-particles. It is shown that under certain conditions more than one type of equilibrium configuration is possible. Stability with respect to density perturbations is investigated. Shorter notices: D. A. Franck-Kamenetsky, *Non-linear oscillations in stars* [*Dokl. Akad. Nauk SSSR*, **86,** 897 (1952). See also Abstr. 6004 (1951), 2385 (1952)]. S. A. Gevakin, *Discrete stellar models* [*Astron. J. USSR*, **29,** 38 (1952)] in which a star is considered as a system of discrete elements instead of as a continuous medium.

R. A. NEWING

523.877

9898. Rotation and stellar evolution. L. Mestel. *Mem. Soc. Roy. Sci. Liège,* **14,** *Special No.*, 213–20 (1954).

Recent estimates of mixing by meridional circulation are modified by taking account of the departure from spherical symmetry arising from material transport by the rotational currents. The general effect of the new considerations is to decrease still further the probability of rotational mixing between core and envelope. R. A. NEWING

523.877

9899. The problem of the subgiants. O. Struve. *Mem. Soc. Roy. Sci. Liège,* **14,** *Special No.*, 236–53 (1954).

The location of the components of eclipsing binaries in the H–R diagram is discussed and the parameter λ in the Massevich–Parenago relations

$L = f_1(M, \lambda)$, $R = f_2(M, \lambda)$ is identified with the mass ratio of the components. The occurrence of λ in these relations is related to a hydrogen deficiency in the secondary produced in the initial process of formation of a close double star with a large mass ratio. R. A. NEWING

523.877

9900. Research on a stellar model for a red giant. P. DUMÉZIL-CURIEN. *Ann. Astrophys.*, **17**, 197–230 (*May–June*, 1954) *In French.*

Based on the following mean values for the effective temperature, T_e, and luminosity, L, of the Cepheid, η Aql., viz. $T_e = 5120°K$, and $L = 1{\cdot}27 \times 10^{37}$ erg. sec^{-1}, models have been constructed with discontinuous chemical composition between an outer region of low molecular weight, and an inner core of high molecular weight. The outer zone comprises a deep layer in convective equilibrium. With a mass of 2·4 times smaller than that required by the mass-luminosity law ($g_0 = 32{\cdot}8$) and a convective zone occupying 2/3 stellar radius, the mean-free-path parameter $k = 4{\cdot}5$, the central temperature is too low, viz. $6{\cdot}8 \times 10^6$ °K. For a slightly smaller k, both mass and central temperature are more representative of actual conditions, the convective zone still occupying an appreciable fraction of the stellar radius. D. R. BARBER

523.877 : 537.533.74

9901. A composite electron-scattering opacity stellar model. A. E. ROY. *Mem. Soc. Roy. Sci. Liège*, **14**, *Special No.*, 139–52 (1954).

In extending previous work to the case of electron scattering it is found necessary, in order to ensure stability at the interface, to include a transition region of variable molecular weight between core and envelope, but this model does not differ much in physical properties from the two-region model involving a simple discontinuity in molecular weight. R. A. NEWING

523.877 : 538.1

9902. Force-free magnetic fields. R. LÜST AND A. SCHLÜTER. *Z. Astrophys.*, **34**, *No.* 4, 263–82 (1954) *In German.*

The astrophysical significance of fields for which the pondero-motive force is zero is discussed and general equations are derived for rotationally symmetric fields. The case for which the current is proportional to the magnetic intensity is examined in detail and a solution is obtained for a dipole field. Field lines within a certain sphere are closed, and the problem of fitting interior and exterior fields is considered. Applications to stationary motion (rotating stars) are discussed. R. A. NEWING

523.877 : 539.17

Experimental and theoretical results on nuclear reactions in stars. *See Abstr.* 10485

529.78

9903. Improved principles for the maintenance of astronomical pendulums. P. BACCHUS. *J. Phys. Radium*, **15**, S 49–S 50 (*June*, 1954) *In French.*

In place of a mechanical maintaining system where the beginning and end of the maintaining impulse are defined by material contacts between moving pieces, an optical method is described and is used in conjunction with an electrostatic method of supplying energy to the pendulum. Improvement in constancy of time period is claimed among other advantages of the system. G. F. HODSMAN

PHYSICS 53

53.081.6

9904. A new method for the precise determination of *h*/*e*. K. SIEGBAHN. *Appl. sci. Res. B*, **4**, *No.* 1–2, 25–33 (1954).

A new β-spectrometric method of measuring h/e by using conversion electron lines is proposed. The energy difference between atomic shells is obtained directly in electron volts and this quantity is compared to the corresponding frequency. The accuracy of the method is quantitatively discussed. A.

FUNDAMENTALS 530.1

530.1

9905. On the relations between the different systems of physical concepts. W. DÖRING. *Z. Phys.*, **138**, *No.* 3–4, 290–300 (1954) *In German.*

The essential difference between physical concepts (Begriffe) and magnitudes (Grösse) is explained, e.g. the concepts *work* and *torque* are different but their magnitudes may be the same. Two concepts have the same "Grössenart" [see Fleischmann, Abstr. 6720 (1951)] if the ratio of their magnitudes is a number, and have the same character if the ratio is a natural constant. It is maintained that Fleischmann incorrectly equates the "Begriff" to "Grössenart." It is shown, using the electrotechnical five-unit system and the electrostatic charge system as examples, that the various systems in use in physics differ only in their use of concepts of equal character, but that these are denoted by the same names and are therefore often confused. S. WEINTROUB

530.1

9906. The system of physical concepts as a many-dimensional point lattice. R. FLEISCHMANN. *Z. Phys.*, **138**, *No.* 3–4, 301–8 (1954) *In German.*

See Abstr. 6720 (1951). The representation of the algebraical structure of the system by a point lattice is further developed and discussed for particular cases. S. WEINTROUB

530.12

9907. Physical sense of the 5-dimensional space in 5-optics. YU. B. RUMER. *Zh. éksper. teor. Fiz.*, **24**, *No.* 3, 312–18 (1953) *In Russian.*

Two different ways lead to 5-optics, the first of which is a development of Hamilton–Schrödinger's

optico-mechanical analogy, the physical content of which is not yet exhausted by modern quantum mechanics. This enables the action ascribed to the material point to be interpreted as the fifth co-ordinate of its configurational space. To obtain agreement with experiment it must be assumed that the configurational 5-space of the material point is topologically closed in the 5th co-ordinate of action, and that the period of the 5th co-ordinate has the microscopic dimension of Planck's constant. The formal apparatus of point mechanics is then fused with the formal apparatus of conventional optics into the unified apparatus of 5-optics. The second way is a continuation and development of the 5-dimensional generalization of gravitational theory attempted in the author's previous papers [see Abstr. 2925 (1953)]. It is shown that both ways are complementary. It is therefore incorrect to consider 5-optics only as one of the variants of unified field theory, its main content being rather a synthesis of the ideas of modern theory of gravitation rooting in Lobachevskii's teachings, with the ideas of quantum theory and the theory of elementary particles. In 5-optics quantization appears as a manifestation of the periodic dependence of all physical fields (classical as well as ψ-fields) on the fifth co-ordinate of action.

B. F. KRAUS

530.12

9908. Foundations for a linear field theory. W. SCHERRER. *Z. Phys.*, **138,** *No.* 1, 16–34 (1954) *In German.*

A "linear differential geometry" is developed in which the invariant quadratic form is replaced by a set of invariant linear differential forms. An extended tensor analysis is developed, involving "form tensors" invariant under the affine group as well as co-ordinate tensors invariant under the group of co-ordinate transformations, and analogues are obtained of the Christoffel symbols and the curvature tensor. A variation principle is introduced in which the action function is a scalar analogous to Riemannian curvature. The theory provides an invariant formulation of the conservation laws. R. A. NEWING

530.12

9909. Equations of motion and non-harmonic co-ordinate conditions. L. INFELD. *Bull. Acad. Polon. Sci. Cl.* 3, **2,** *No.* 4, 163–6 (1954).

It is maintained that the Fock–Einstein–Infeld approximation procedure in deriving the equations of motion for two bodies is sufficiently stringent to ensure a proper co-ordinate system. The point is illustrated by deriving the Newtonian equations by a modification of Fock's method not involving the harmonic co-ordinate condition. R. A. NEWING

530.12

9910. The general static spherically symmetric solutions of Einstein's latest unified theory. F. DE SIMONI. *R.C. Accad. Naz. Lincei,* **16,** 348–55 (*March,* 1954) *In Italian.*

The general solutions derived for the 1953 theory include as special cases solutions obtained by Papapetrou, Wyman and Bonnor for earlier forms of the theory. R. A. NEWING

530.12

9911. On the two-body problem in general relativity. B. BERTOTTI. *Nuovo Cimento,* **12,** 226–32 (*Aug.,* 1954).

The Hoffmann–Einstein–Infeld equations can be understood with the assumption that each body moves along a geodesic in the field of the other one, due regard being paid to the acceleration the second body experiences from the first. A.

530.12

9912. Gravitational field equations. R. L. KIRKWOOD. *Phys. Rev.*, **95,** 1051–6 (*Aug.* 15, 1954).

Arguments are given to show that the laws that determine the motion of the ether should not refer to the motion of anything that is not in the immediate vicinity of the point whose motion is being considered. From this assumption and from Newton's laws of gravitation, the equations of motion of the ether are derived. A.

530.145

9913. On Feynman's "integral over all paths." B. DAVISON. *Proc. Roy. Soc. A,* **225,** 252–63 (*Aug.* 31, 1954).

A definition of Feynman's "integral over all paths" is given in precise mathematical terms, namely, it is shown, subject to some restrictions on the nature of the Lagrangian, that the ratio of the "integral" to a certain normalization factor is uniquely determined by postulating: (i) the composition law, (ii) the possibility of taking any factor independent of the paths outside the integration over paths, and (iii) that the quantity in question should not involve any arbitrary "universal" constants of the dimensions of inverse time. The nature of the normalization factor, referred to above, is also examined. Finally, a method of parametrization of paths is introduced, and it is shown that Feynman's "integral over all paths" can, alternatively, be defined in terms of this parametrization. A.

530.145

9914. On the interaction of microsystems with the zero-point vibrations of the electromagnetic field. E. I. ADIROVICH AND M. I. PODGORETSKIĬ. *Zh. éksper. teor. Fiz.*, **26,** *No.* 2, 150–2 (1954) *In Russian.*

The microsystems considered are the harmonic and anharmonic oscillators and an electron in a constant magnetic field. The position and momentum of the harmonic oscillator show a spread coinciding with the quantum-mechanical spread. G. E. BROWN

530.145

9915. On the solution of the equations of field theory. III. Two coupled fields. G. RIDEAU. *C.R. Acad. Sci. [Paris]* **238,** 2288–90 (*June* 14, 1954) *In French.*

An extension of methods previously developed [Abstr. 8029 (1954)] to the case of two quantized fields, coupled by an interaction of the conventional type. P. T. MATTHEWS

530.145

9916. The coupling constant in field theory. G. KÄLLÉN. *Nuovo Cimento,* **12,** 217–25 (*Aug.,* 1954).

The various possible definitions of the coupling constant in quantum electrodynamics and in meson theory are reviewed and their properties are discussed. It is pointed out that the gauge invariance of quantum

electrodynamics makes the definition of the renormalized charge unique, at least in a certain sense. This simplification does not occur in meson theory where the definition of the coupling constant is more ambiguous. A recent attempt at comparing different mesic charges is discussed. A.

530.145

9917. Some generalizations of the Foldy–Wouthuysen transformation. K. M. CASE. *Phys. Rev.*, **95**, 1323–8 (*Sept.* 1, 1954).

A canonical transformation similar to that given by Foldy and Wouthuysen is obtained for the spin zero and one theories. For free particles positive and negative charge states are separately described by one or three component wave functions. It is found that the resulting forms for operators and the nonrelativistic limits are quite similar to that for spin $\frac{1}{2}$. The resulting similarity is found to carry over to still higher spins. Particles moving in magnetic fields are described most simply using the transformed representation. A.

530.145

9918. On the theory of meson fields. I. Vector field of general type in the vacuum. A. A. BORGARDT. *Zh. éksper. teor. Fiz.*, **24**, *No.* 1, 24–32 (1953) *In Russian.*

This paper constitutes a formal study of the noncommutative algebra formed by the Duffin–Kemmer β-matrices in their reducible representation. These matrices are used in wave-equations for particles with integer spin. The equations are cast in such a form that supplementary conditions are not necessary. Field variables are related to canonical variables.

G. E. BROWN

530.145

9919. On the theory of meson fields. II. Field with sources. A. A. BORGARDT. *Zh. éksper. teor. Fiz.*, **24**, *No.* 3, 284–92 (1953) *In Russian.*

Equations of motion are obtained from the 16-dimensional equation of Pt I. Various invariants are formed from the matrices of the algebra and related to physical quantities. The theory of neutral quanta of integer spin is considered in detail, especially in the limit of zero self-energy. A perturbation theory is formulated. G. E. BROWN

530.145

9920. Quantization of fields obeying equations with higher derivatives. I. A. V. GUREVICH. *Zh. éksper. teor. Fiz.*, **24**, *No.* 2, 149–66 (1953) *In Russian.*

Wave equations of the type $P_n(\Box)\psi = -4\pi\rho$ (where $\Box$ is the D'Alembertian and P_n signifies a polynomial of order n) are discussed. A Hamiltonian method is developed for these field equations and quantization is carried through. The connection between such equations and equations describing particles with higher spin is discussed. G. E. BROWN

530.145

9921. Some physical consequences of vacuum polarization. L. L. FOLDY AND E. ERIKSEN. *Phys. Rev.*, **95**, 1048–51 (*Aug.* 15, 1954).

The phenomenon of vacuum polarization can be studied apart from other higher-order electrodynamic effects through its modification of the electrostatic interaction of heavy charged particles. In particular the principal deviations of the $2p$–$1s$ level separations from the Bohr formula in light μ-mesonic atoms ($Z \leqslant 6$) are expected to arise from vacuum polarization effects rather than relativistic effects (ordinary hydrogenic fine structure) or finite nuclear size. The vacuum polarization contribution to the electrostatic interaction of two protons requires slight changes in the usual analysis of proton–proton scattering data to obtain information about nuclear forces. The effect of vacuum polarization on the electrostatic energies of nuclei is also briefly discussed. A.

530.145

9922. Hyperquantization of Feynman amplitudes. F. COESTER. *Phys. Rev.*, **95**, 1318–23 (*Sept.* 1, 1954).

A hyperquantization formalism is presented which employs an occupation-number representation for the set of all Feynman amplitudes. The relation between the amplitudes and the occupation number representation is quite similar to that between the Fock amplitudes and the occupation number representation commonly used in the theory of quantized fields. The differential equations for the Feynman amplitudes can be written and manipulated in a more compact form in this representation. Formal solutions of these equations are given and the connection with the S-matrix formalism is discussed. A.

530.145

9923. Fierz–Pauli theory of particles of spin 3/2. S. N. GUPTA. *Phys. Rev.*, **95**, 1334–41 (*Sept.* 1, 1954).

The Fierz–Pauli field corresponding to particles of spin $\frac{3}{2}$ is quantized, and its interaction with the electromagnetic field is investigated. It is also shown how the elements of the S-matrix for collision processes, involving photons and charged particles of spin $\frac{3}{2}$, can be obtained in a simple way. A.

530.145 : 535.51 : 538.566

9924. Polarization and the Stokes parameters. W. H. MCMASTER. *Amer. J. Phys.*, **22**, 351–62 (*Sept.*, 1954).

The Stokes parameters have been found to offer a very convenient method for the description of polarization of both electromagnetic radiation and elementary particles. Their development is presented along with some applications to physical problems. A.

530.145

9925. Quantum electrodynamics in configuration representation. I. YU. M. SHIROKOV. *Zh. éksper. teor. Fiz.*, **24**, *No.* 1, 14–23 (1953) *In Russian.*

The radiation field is treated, and quantized in configuration space so that the wave function has the usual sense as a Schrödinger function. The system of two photons is discussed in detail, especially with respect to the angular distribution of annihilation radiation. The method of Fock of representing wave equations on different numbers of particles in configuration space is employed. G. E. BROWN

530.145

9926. Quantum electrodynamics in configuration representation. II. Theory of electrons and positrons in configuration representation. YU. M. SHIROKOV. *Zh. éksper. teor. Fiz.*, **24**, *No.* 2, 129–34 (1953) *In Russian.*

The electron and positron are viewed as two different (positive energy) states of the same particle.

G. E. BROWN

530.145

9927. Quantum electrodynamics in configuration representation. III. Interaction of electrons and positrons with the electromagnetic field. YU. M. SHIROKOV. *Zh. éksper. teor. Fiz.*, **24**, *No.* 2, 135–48 (1953) *In Russian.*

The fields described in Pts I and II are treated in the same spirit here, but with a coupling term which allows a description of annihilation of two positive energy particles. The formulation contains nothing essentially new, being equivalent with formulations in momentum space. G. E. BROWN

530.145

9928. Conservation theorems in modified electrodynamics. J. W. DETTMAN AND A. SCHILD. *Phys. Rev.*, **95**, 1057–60 (*Aug.* 15, 1954).

A system of interacting particles with variable rest masses is considered, whose motion is governed by a variational principle of general form, in which there are self-action terms instead of the usual specifically inertial terms. For suitable restrictions of the action principle it is shown that, when the particles are at distances large compared to the classical electron radius, the new theory reduces to classical electrodynamics and the variable rest masses become constants of the motion. The conservation laws of energy-momentum and of angular momentum are derived from the Lorentz invariance of the general action principle. A.

530.145

9929. Quantum electrodynamics at small distances. M. GELL-MANN AND F. E. LOW. *Phys. Rev.*, **95**, 1300–12 (*Sept.* 1, 1954).

The renormalized propagation functions D_{FC} and S_{FC} for photons and electrons, respectively, are investigated for momenta much greater than the mass of the electron. It is found that in this region the individual terms of the perturbation series to all orders in the coupling constant take on very simple asymptotic forms. An attempt to sum the entire series is only partially successful. It is found that the series satisfy certain functional equations by virtue of the renormalizability of the theory. If photon self-energy parts are omitted from the series, so that $D_{FC} = D_F$, then S_{FC} has the asymptotic form $A[p^2/m^2]^n[i\gamma \cdot p]^{-1}$, where $A = A(e_1^2)$ and $n = n(e_1^2)$. When all diagrams are included, less specific results are found. One conclusion is that the shape of the charge distribution surrounding a test charge in the vacuum does not, at small distances, depend on the coupling constant except through a scale factor. The behaviour of the propagation functions for large momenta is related to the magnitude of the renormalization constants in the theory. Thus it is shown that the unrenormalized coupling constant $e_0^2/4\pi\hbar c$, which appears in perturbation theory as a power series in the renormalized coupling constant $e_1^2/4\pi\hbar c$ with divergent coefficients, may behave in either of two ways: (*a*) it may really be infinite as perturbation theory indicates; (*b*) it may be a finite number independent of $e_0^2/4\pi\hbar c$. A.

530.145 : 538.3

9930. Electrodynamics with higher derivatives as a particular case of electrodynamics with non-linear equations. Z. SZYMAŃSKI. *Bull. Acad. Polon. Sci. Cl.* 3, **2**, *No.* 4, 167–9 (1954).

The Infeld–Plebański theory [Abstr. 5284 (1954)] is modified by introducing a new definition of current, $j_\alpha = (1 - a^2\Box)p_{\alpha\beta,\beta}$ where a is a constant. The theory then includes Podolsky's linear theory (1948) as a special case. R. A. NEWING

530.145

9931. On a theory of interaction of a three-dimensional extended particle with an external field. YU. M. SHIROKOV. *Zh. éksper. teor. Fiz.*, **24**, *No.* 1, 47–55 (1953) *In Russian.*

Equations of motion and invariants are formulated in four dimensions, but the particle has only a three-dimensional extension. In the non-relativistic limit the theory is connected with the Lorentz theory of extended charged spheres. G. E. BROWN

530.145

9932. On the renormalization of Salpeter–Bethe kernel of meson-nucleon system in state $T = 1/2$. T. YOSHIMURA. Letter in *Progr. theor. Phys.*, **11**, 224–5 (*Feb.*, 1954).

A purely formal renormalization of the equation is carried out. P. T. MATTHEWS

530.145

9933. On field equations with non-local interaction. C. HAYASHI. Letter in *Progr. theor. Phys.*, **11**, 226–7 (*Feb.*, 1954).

Extending the results given previously [Abstr. 5277 (1954)] it is shown that, with a symmetrized interaction and certain invariance conditions on the form factor, it is possible to construct field equations of simple form, and for which $\phi(x, +\infty)$ vanishes if $\phi(x, -\infty)$ vanishes. P. T. MATTHEWS

530.145 : 539.18

9934. Are large energy transfers consistent with non-local interactions? F. KORTEL. *Z. Phys.*, **138**, *No.* 2, 192–208 (1954) *In German.*

By examples of a strong and a weak coupling, represented by the Schiff and the Born equations respectively, the effect of a non-local interaction on multiple meson emission in the collision of very vast nucleons is examined, qualitatively, without quantization, on Heisenberg's theory [Abstr. 1942 (1953)]. It is established that a non-local interaction does not enhance large energy transfers, but leads rather to a smaller number of mesons, with slightly larger energy, than the local theory. P. T. MATTHEWS

530.145

9935. Tamm–Dancoff method. J. C. TAYLOR. *Phys. Rev.*, **95**, 1313–17 (*Sept.* 1, 1954).

The Tamm–Dancoff equations are expressed in a concise four-dimensional form. The difficulty of renormalizing the new Tamm–Dancoff equation of Dyson is discussed. The Lévy–Klein approximation to the Bethe–Salpeter equation is derived as an approximation to the old Tamm–Dancoff equation, and a new renormalizable equation is derived analogously to the new Tamm–Dancoff equation. The latter approximation is better than the former. A.

530.145

9936. Some special examples in renormalizable field theory. T. D. LEE. *Phys. Rev.*, **95**, 1329–34 (*Sept.* 1, 1954).

Some special problems of interacting fields that

contain removable divergences are treated in detail. Comparisons with the power series renormalization procedures are made. Examination of the closed forms of the solutions before and after renormalization shows that, in one special case solved, coupling-constant renormalization cannot be obtained by any limiting processes that involve only real values of the unrenormalized coupling constant. A.

530.145

9937. Problem of the transverse energy of the electron in a linear generalization of electrodynamics. V. K. PETERSON. *Zh. éksper. teor. Fiz.*, **24**, *No.* 1, 56–64 (1953) *In Russian.*

The transverse self-energy of the electron is calculated using the Bopp–Podolsky generalization of quantum electrodynamics and Dirac hole theory. It is found to be positive. An error in a previous work [Abstr. 3426 (1947)] in which a negative self-energy was found, is pointed out. G. E. BROWN

530.145

9938. Part played by the gravitational field in the formation of the mass of an electron. YA. I. PUGACHEV AND M. F. SHIROKOV. *Zh. éksper. teor. Fiz.*, **24**, *No.* 4, 375–82 (1953) *In Russian.*

Investigates the gravitational field of a point charge the electromagnetic field of which is determined by equations of linear electrodynamics with higher derivatives. As a rule, the gravitational field is found to be divergent, and both the mass m and charge e_0 of the particle are introduced into the theory as integration constants independent of each other. The regular solution can only be obtained when a definite relationship exists between m and e_0. Unlike in the special theory of relativity, the mass cannot be of electromagnetic origin only. Its gravitational part is found to be $\sim e^2k_0/8c^2$, and so cannot be neglected even in the first approximation. See also Abstr. 44–45 (1949). F. LACHMAN

530.145

9939. On the program of a systematization of particles and interactions. A PAIS. *Proc. Nat. Acad. Sci. U.S.A.*, **40**, 484–92 (*June*, 1954).

The baryon (hyperon or nucleon) is considered as a semispinor with respect to $0_1(4)$, the group of four-dimensional real orthogonal transformations with determinant equal to $+1$. Operations are carried out in a generalized isotopic spin space. Interactions invariant under $0_1(4)$ are considered, and qualitative features of a possible baryon classification are discussed. G. E. BROWN

530.145

9940. Huygens' principle in Dirac electron theory and contour integrals. P. VAN LOC. *C.R. Acad. Sci.* [*Paris*] **238**, 2494–6 (*June* 28, 1954) *In French.*

530.145

9941. On a relativistic theory of the interaction of nucleons. I. E. TAMM, V. P. SILIN AND V. YA. FAINBERG. *Zh. éksper. teor. Fiz.*, **24**, *No.* 1, 3–13 (1953) *In Russian.*

It is shown that a relativistic treatment of two nucleons interacting through a pseudoscalar meson field with pseudovector coupling does not alter a previous conclusion [I. Tamm, *Journal of Physics, USSR*, **9**, 449 (1945)] about the instability of the system because of the pole at $r = 0$. The potential obtained from second-order perturbation theory is considered. In another section, the work of Levy [Abstr. 80 (1952)] concerning pseudoscalar mesons with pseudoscalar coupling is considered. It is shown that his conclusions of no binding and infinite energy for the two-nucleon system, are incorrect. G. E. BROWN

530.145

9942. On a covariant generalization of Tamm–Dancoff approximation for pion-nucleon scattering. K. ITABASHI. Letter in *Progr. theor. Phys.*, **11**, 227–8 (*Feb.*, 1954).

The Green functions for a nucleon, with emission or absorption of various numbers of mesons, satisfy an infinite set of coupled integral equations. It is proposed that these should be solved by a generalized Tamm–Dancoff approximation. P. T. MATTHEWS

530.145

9943. Renormalization in generalized Tamm–Dancoff approximation for pion-nucleon scattering. K. ITABASHI. Letter in *Progr. theor. Phys.*, **11**, 228–30 (*Feb.*, 1954).

The renormalization of the equations of the preceding abstract. P. T. MATTHEWS

530.145

9944. Two-body forces and nuclear stability. D. H. FRISCH. Letter in *Phys. Rev.*, **95**, 865–6 (*Aug.* 1, 1954).

The possibility is considered that a linear superposition of the central two-body forces, observed in p-p and n-p scattering, can alone give negative potential energies sufficient to account for observed nuclear binding and stability, if a nuclear radius of $1{\cdot}1A^{\frac{1}{3}}\times10^{-13}$ cm is assumed. The rough indication is that two-body forces, or simply related many body forces, might be sufficient. P. T. MATTHEWS

530.145

9945. On the relation between the time-dependent and stationary treatments of collision processes. F. J. BELINFANTE AND C. MØLLER. *K. Danske Vidensk. Selsk., mat-fys. Medd.*, **28**, *Paper* 6, 64 *pp.* (1954).

Critical review of methods in collision theory, considering definitions and representations of scattering matrices, the necessity of employing perturbation expansions, the significance of their convergence, discussing difficulties which arise from the existence of bound states and correlating the approach by different authors rather than applying the theory to specified problems. R. EISENSCHITZ

530.145

9946. *P*-wave pion nucleon scattering by variational method. L. SARTORI AND V. WATAGHIN. Letter in *Nuovo Cimento*, **12**, 145–7 (*July*, 1954).

The *P*-wave phase shift is calculated by the method of Cini and Fubini [Abstr. 3121 (1954)] using the extended source approximation to the pseudoscalar interaction. Using a cut-off at the nucleon mass and a coupling constant of $g^2 = 11{\cdot}7$ a fit has been obtained to the Glicksman (*Phys. Rev.*, published later) phase shifts. The results of the first approximation of this method closely resemble the exact numerical solution of Chew (see abstract following). P. T. MATTHEWS

530.145

9947. Improved calculation of the *P*-wave pion-nucleon scattering phase shifts in the cut-off theory. G. F. CHEW. Letter in *Phys. Rev.*, **95**, 285–6 (*July* 1, 1954).

An improved calculation along the lines suggested previously by the author [Abstr. 2203 (1953), 8059–60 (1954)] using a Fredholm approximation with the parameters, cut-off and coupling constant, chosen to give a resonance near 200 MeV. P. T. MATTHEWS

530.145

9948. Numerical calculation of 3/2–3/2 pion-nucleon reaction matrix and phase shifts. F. F. SALZMAN AND J. N. SNYDER. Letter in *Phys. Rev.*, **95**, 286–7 (*July* 1, 1954).

The Fredholm equation for the reaction matrix in the formulation due to Chew (preceding abstract) has been solved numerically with the same choice of parameters. P. T. MATTHEWS

530.145

9949. Pion-nucleon scattering by variational method. L. SARTORI AND V. WATAGHIN. *Nuovo Cimento*, **12**, 260–9 (*Aug.*, 1954).

S-wave phase-shifts in pion nucleon scattering are calculated in a non-relativistic approximation of the *PS* (*PS*) theory with a cut-off at the nucleon mass. The variational procedure proposed by Cini and Fubini is applied; charge renormalization is performed in a manner similar to that used by Deser, Thirring and Goldberger. For pion energy sufficiently high, the phase shifts found have the correct sign and qualitative energy dependence; however, the magnitudes are much too large. A.

530.145

9950. Structure of the nucleon. II. Pion-nucleon scattering. R. G. SACHS. *Phys. Rev.*, **95**, 1065–78 (*Aug.* 15, 1954).

For Pt I, see Abstr. 7970 (1954). The scattering of pions by nucleons is treated on the basis of the assumption that the nucleon has a rather complex structure consisting of a core surrounded by varying numbers of pions in certain bound states. The scattering phase shift is found to be composed additively of two parts, an orthogonality phase shift determined by the condition that the incoming wave be orthogonal to the bound field and a phase shift due to the interaction between the incoming wave and the bound field plus core. The former phase is shown to be negative at low energy and to decrease rapidly with increasing energy. The other term is found to have a typical resonance behaviour. Each of the parameters appearing in the formulae for the phase shifts is given a rather direct physical interpretation. When the parameters are chosen in such a way as to give a good over-all fit to the data up to 400 MeV the following picture of the nucleon emerges: The bound field consists of *P*-waves concentrated at a small distance ($\frac{1}{4}$ the pion Compton wavelength) from the core and *S*-waves extending to about twice that distance. The states of excitation (resonances) of the bound field consist of the usual *P* resonance with $J = \frac{3}{2}$, $I = \frac{3}{2}$, and a much broader *S*-wave resonance with $I = \frac{1}{2}$. Indications are that all other states of excitation lie higher (above 300 MeV) and are smeared out into a continuum through the emission of virtual pion pairs. A.

530.145

9951. Suppression of pair coupling in nuclear forces. A. KLEIN. *Phys. Rev.*, **95**, 1061–4 (*Aug.* 15, 1954).

It is demonstrated that for the nuclear force problem the effective coupling constant for the emission of a pair of mesons is the same as the renormalized coupling constant, $g_s^2/4\pi$, which occurs in the matrix element for meson-nucleon scattering in the low energy limit. The proof involves an adaptation of the techniques developed by Deser, Thirring and Goldberger for the scattering problem. The relatively small value of the coupling constant thus obtained, $g_s^2/4\pi \sim 1$, can be interpreted as the consequence of a net pair suppression, although not in the narrow sense associated with the nucleon propagation function alone. Radiative corrections to multiple pair vertices are considered briefly. A.

530.145 : 539.18

Mesons and nuclear forces. *See Abstr.* 10522

530.145

9952. On relativistic effects in the interaction of nucleons. P. E. KUNIN AND I. M. TAKSAR. *Latv. PSR Zināt. Akad. Vēstis*, **1952**, *No.* 8, 137–54. *In Russian.*

The equation between two nucleons is taken in the form $\{-E + \boldsymbol{\alpha}^{\mathrm{I}}\mathbf{p}^{\mathrm{I}} + \boldsymbol{\alpha}^{\mathrm{II}}\mathbf{p}^{\mathrm{II}} + (\rho_3^{\mathrm{I}} + \rho_3^{\mathrm{II}})E_0 + U\}\psi = 0$ where $\boldsymbol{\alpha}$, ρ_3 are Dirac matrices, E_0 is the nucleon rest mass energy and the superscripts I and II refer to the two different nucleons. Various forms of U, a three-dimensional potential (although possibly velocity dependent) are considered, as suggested by various meson theories. Angle variables are eliminated from the equations, which are then separated into two groups describing states which become singlet and triplet states in the non-relativistic limit. The radial equations so obtained are discussed, and conditions for regular solutions are given in detail. No application of these equations is made in this paper. G. E. BROWN

530.145

9953. Harmonic oscillator wave functions. I. R. SENITZKY. *Phys. Rev.*, **95**, 1115–16 (*Sept.* 1, 1954).

A harmonic oscillator wave packet which oscillates sinusoidally without change in shape has been described by Schrödinger and others. It is shown in the present note that there are an infinite number of such wave packets—of which the above is a special one—having the shapes of the various eigenfunctions of the harmonic oscillator Hamiltonian. The relation of these wave packets to the classical oscillator is discussed. A.

530.162

9954. Elements of statistical mechanics. D. TER HAAR. *New York: Rinehart & Company* (1954) xix + 468 *pp.*

A textbook dealing with fundamental theory and applications. Contents: Pt A, statistics of independent particles: the Maxwell distribution, the Maxwell–Boltzmann distribution, quantum statistics, Bose–Einstein and Fermi-Dirac statistics; Pt B, ensemble theory: petit ensembles, classical grand ensembles,

the ensembles in quantum statistics; Pt C, applications: the equation of state, condensation phenomena, the elementary electron theory of metals, semiconductors, co-operative phenomena, statistical methods in nuclear physics, the equilibrium theory of the origin of the chemical elements, the statistical theory of rubber elasticity. Appendices deal with the following more advanced topics: the H-theorem and the ergodic theorem, irreversible processes, the third law of thermodynamics, the Darwin–Fowler method, intermolecular forces, relativistic statistics. There is a table of physical and mathematical constants, and a mathematical appendix. Bibliographical notes follow each chapter. E. H. SONDHEIMER

530.162

9955. On the problem of the distribution function for systems with Coulomb interaction. E. A. STREL'TSOVA. *Zh. éksper. teor. Fiz.*, **26**, *No.* 2, 173–8 (1954) *In Russian.*

The integral equation for the distribution function for an assemblage of molecules with Coulomb interactions is expanded in powers of a parameter, and the equations of first and second order are considered. This parameter is $\varepsilon = Vx^3/N$ where V is the volume, N is the number of particles and x is the inverse of the Debye radius. The equation in first order in ε is Debye equation. G. E. BROWN

530.162 : 533.7

The statistical-mechanical theory of transport processes. *See Abstr.* 9983

MECHANICAL MEASUREMENTS 531.7

531.717.7

9956. A note on the design of the spherometer. H. S. C. CHEN. *Amer. J. Phys.*, **22**, 374–5 (*Sept.*, 1954).

A discussion is made of the errors involved in the use of a spherometer, and it is shown that the accuracy is limited by the accuracy with which the radius of the base circle is measured. A suggested change in design is given, which promises to mean easier manufacture and higher accuracy. A.

531.79

9957. A sensitive floor for examining the movement of traffic. R. G. BATESON. *J. sci. Instrum.*, **31**, 336–7 (*Sept.*, 1954).

In some investigations into the efficiency of buildings from the user point of view, it is frequently necessary to relate the movements of people, pursuing various activities, to the environment provided within the building, e.g. the form of access, positioning of fixed and movable equipment and the free floor space available. While the activities of the subject are fairly readily observed visually and recorded, the position of the subject at any instant is difficult to fix accurately unless the floor is marked off in a grid, which is artificial and disturbing. A simple installation which enables the position of the subject to be automatically and continuously recorded has been developed. It makes use of an electrically operated "sensitive mat," comprising two conducting layers insulated from each other by a discontinuous intermediate layer of resilient material. Under a sufficiently high pressure, e.g. due to that of a foot, the two conducting layers are brought into contact and remain in contact until the pressure is released. One method of obtaining a continuous record of the time and position of pressure on the floor is described. A.

MECHANICS OF FLUIDS 532

532.123

9958. Navier–Stokes' equations for non-Newtonian liquids. A. A. K. IBRAHIM. Letter in *J. chem. Phys.*, **22**, 1274 (*July*, 1954).

A displacement term is included in the general hydrodynamical equations for a viscous liquid to include the elastic properties of non-Newtonian liquids. The new term has the form $(N/\rho)\nabla^2 S$ (N = modulus of rigidity). T. C. TOYE

532.13 : 532.77

9959. The viscous behaviour of moderately concentrated macromolecular solutions. A. PETERLIN. *Rheology Congress Proceedings*, 343–9 [see Abstr. 10588 (1954)].

A theory is advanced which explains some of the main features of viscosity and birefringence observations on some nitrocellulose and polystyrene solutions, at concentrations such that the viscosity of the solution, relative to that of the solvent, is in the range 1–1000. A particular molecule is considered to be, in effect, surrounded by liquid of a certain viscosity, intermediate between those of the solvent and the solution. J. G. OLDROYD

532.13 : 541.24

9960. Viscosity and molecular weight of macromolecules. K. EDELMANN. *Rheology Congress Proceedings*, 107–15 [see Abstr. 10588 (1954)].

A method of calculating the molecular weight of a polymer, from viscosity measurements on solutions, is based on the observation of the point of inflexion in a plot of log (shear stress) v. log (velocity gradient); this is found to be at a constant velocity gradient, independent of polymer concentration.

J. G. OLDROYD

532.13 : 541.42

Viscosity and electroviscous effect of emulsions. *See Abstr.* 10614

532.24

9961. The instability of a layer of fluid heated below and subject to the simultaneous action of a magnetic field and rotation. S. CHANDRASEKHAR. *Proc. Roy. Soc. A*, **225**, 173–84 (*Aug.* 31, 1954).

An examination of the stability of a horizontal layer of fluid heated below, subject to an effective gravity **g** acting (approximately) in the direction of the vertical, a magnetic field **H** and the Coriolis acceleration resulting from a rotation **Ω**. When **g**, **H** and **Ω**

are parallel, the critical Rayleigh number (R_c) at which convection sets in depends on H and Ω through the non-dimensional parameters $Q = \mu^2 H^2 d^2 \sigma/\rho\nu$ and $T = 4\Omega^2 d^4/\nu^2$ where μ, σ and ν are the coefficients of magnetic permeability, electrical conductivity and kinematic viscosity, respectively, and d is the depth of the layer considered. In the case when the liquid is confined between two free boundaries the dependence of R_c on Q and T is explicitly established. The results reveal some very unexpected features and illustrate the complex behaviour of a fluid under the simultaneous action of a magnetic field and rotation. A.

532.51

9962. Rayleigh's problem for a cylinder of arbitrary shape. H. HASIMOTO. *J. Phys. Soc. Japan*, **9**, 611–19 (*July–Aug.*, 1954).

The motion of an incompressible viscous fluid generated by a cylinder of arbitrary cross-sectional form which is started to move suddenly from rest with uniform velocity in the direction of its length is considered. By using Laplace transform and complex variables, asymptotic expansion formulae in powers of $a^2/(\nu t)$ are derived for the velocity distribution (valid in the vicinity of the cylinder) and for the frictional drag on the cylinder, correct to the order of $a^2/(\nu t)$, where a is the characteristic length of the cross-section, ν is the kinematic viscosity and t is the time. These formulae are given in terms of only the analytic function which maps conformally the region outside the cross-section of the cylinder on to the region outside the unit circle, and of certain integrals $E_n^m(a/\sqrt{\nu t})$ which are common to any arbitrary cylinder. In particular, when $a/\sqrt{\nu t}$ is sufficiently small, the total frictional drag on the cylinder per unit length is expressed as $4\pi\mu W E_0(a/\sqrt{\nu t}) \sim 4\pi\mu W(\beta^{-1} - \gamma\beta^{-2} \ldots)$, irrespective of the cross-sectional form, where $\beta = -2[\gamma + \log(a/\sqrt{4\nu t})]$, and $\gamma = 0{\cdot}5772 \ldots$ (Euler's constant). A.

532.516

9963. Pressure distribution in liquids in laminar shearing motion and comparison with predictions from various theories. J. E. ROBERTS. *Rheology Congress Proceedings*, 91–8 [see Abstr. 10588 (1954)].

A method of measuring all the stress components in a liquid sheared between a cone and a flat plate is described. Measurements on certain non-Newtonian liquids (rubber and xylene, aluminium laurate in paraffin, special Ragosine oils and polyisobutylene in orthodichlorobenzene) establish that the normal pressure along the streamlines is less than the normal pressures in perpendicular directions (which are equal), as predicted by Weissenberg. This result contradicts some of the proposed theories of non-Newtonian flow. J. G. OLDROYD

532.517

9964. Viscosity and anisotropy of flow in monatomic liquids. R. EISENSCHITZ AND A. SUDDABY. *Rheology Congress Proceedings*, 320–3 [see Abstr. 10588 (1954)].

Two alternative assumptions concerning distortion of the radial distribution function in flowing liquids have been put forward which are distinct by involving different degrees of anisotropy of flow. By investigating the mathematical foundations of the theory of liquid viscosity arguments are obtained in favour of the assumption excluding any appreciable anisotropy. A.

532.517.4

9965. Energy spectrum of turbulence for the entire range. R. W. DAVIES. *Phys. Rev.*, **95**, 912–13 (*Aug.* 15, 1954).

The wave-number spectrum,

$$F(k) = \frac{(14\nu\langle u^2\rangle)^{2/3} C k^4 \exp\{-14\nu k^2\langle u^2\rangle/\langle\varepsilon\rangle\}}{[14\nu\langle u^2\rangle + \tfrac{2}{3}k^{13/2}C^{3/2}(1-\exp\{-21\nu k^2\langle u^2\rangle/\langle\varepsilon\rangle\})]^{2/3}}$$

is derived from two limiting laws. The technique is very similar to that employed in black-body radiation. A.

532.52 : 541.182.4

9966. Aspects of the flow of concentrated emulsions. E. G. RICHARDSON. *Rheology Congress Proceedings*, 338–42 [see Abstr. 10588 (1954)].

The trajectory of single oil drops carried in a stream of water past a constriction in a tube has been studied and analysed from the point of view of concentrated emulsions, The relationships between the stress/flow curves in such a model and those of a real emulsion as well as of a viscoelastic liquid in a capillary tube are pointed out. A.

532.525

9967. Mechanism of the disruption of liquid jets. E. G. RICHARDSON. *Appl. sci. Res. A*, **4**, *No.* 5–6, 374–8 (1954).

By means of a technique of micro-flash illumination, photographs are obtained of a water jet issuing from a straight nozzle. Three regimes of flow can be distinguished, each of which results in a special type of break-up into drops. The sinuous type and the type called "atomization" are discussed in the light of theory. A.

532.525

9968. A photographic investigation into the disintegration of liquid sheets. N. DOMBROWSKI AND R. P. FRASER. *Phil. Trans A*, **247**, *No.* 924, 13–130 (1954).

This paper gives further insight into the manner of disintegration of liquid sheets by the use of an improved photographic technique. It establishes the basic mechanisms of thread and drop formation and shows that the liquid threads are principally caused by perforations in the sheet. It shows that the history of the perforations determines the stage of growth at which the threads break up. If the holes are produced by air friction the threads so produced are broken up very rapidly by the air and they may be difficult to observe. If, however, the holes are caused by other means, such as turbulence in the nozzle or suspensions of unwettable particles, the threads are broken more slowly by surface tension. The life history of the holes appears to have an important bearing on the resultant drop size, and it would appear that if the perforations in the sheet could be made to occur at the same distance from the orifice, then the thread diameters and resulting drops could be made to be more uniform. A.

CAPILLARITY 532.6

532.63

9969. Electrostatic atomization of liquids. H. STRAUBEL. *Z. angew. Phys.*, **6**, 264–7 (*June*, 1954) *In German.*

See Abstr. 8262 (1953). Discusses the results of experiments on various organic liquids and suggests a number of applications including that of using finely sprayed charged drops in model experiments on the motion of electrons. M. R. HOPKINS

MOLECULAR THEORY OF LIQUIDS 532.7

532.7 : 534.321.9

9970. Nonlinear quantitative variations of physicochemical actions occurring in a liquid under the action of ultrasound in the presence of a gas at various pressures. R.-G. BUSNEL AND M. DEGROIS. *C.R. Acad. Sci.* [*Paris*] **238**, 2400–2 (*June* 21, 1954) *In French.*

Variation of gas pressures above a liquid irradiated with ultrasound produces a number of peculiar irreversible effects, one example being the disappearance of the ultrasonic fountain with increasing pressure; when the pressure is decreased the fountain reappears but not at the same value of pressure as that at which it disappeared. T. C. TOYE

532.7 : 539.21

Application of a theory of Borelius to the relation between the structure of solid and liquid iron. *See Abstr.* 10544

532.72

9971. Study of the effect of polydispersion and concentration on translation diffusion. M. DAUNE AND H. BENOIT. *J. Chim. phys.*, **51**, 233–9 (*May*, 1954) *In French.*

When the variations introduced by polydispersion and concentration into the process of the translation diffusion of macromolecular substances are not too great, the two phenomena may be evaluated from the experimental data obtained by Scheibling's interferometer method [*J. Chim. phys.*, **47**, 7–8, 688 (1950)]. H. H. HODGSON

532.72

9972. Determination of the coefficients of diffusion of some metals in mercury by means of the amalgam dropping electrode. M. V. STACKELBERG AND V. TOOME. *Z. Elektrochem.*, **58**, *No.* 4, 226–30 (1954) *In German.*

Presents in the form of tables and graphs the results of the determination of the diffusion coefficients of Cd, In, Pb and Na in Hg at 22°C from the intensities of the anodic current; the accuracy of the determination was $\pm 3\%$. The results confirm the theory according to which there exists a diffusion current on dropping electrodes. F. LACHMAN

532.73

9973. Classical statistics in the consideration of the space requirements of particles. II. H. FALKENHAGEN AND G. KELBG. *Ann. Phys.* [*Leipzig*] **14**, *No.* 6–8, 391–6 (1954) *In German.*

Papers by Schlogl and by Dutta and Bagchi are discussed in relation to the authors' original paper [Abstr. 2244 (1953)]. T. C. TOYE

532.73 : 538.22

9974. Theory of magnetic properties of solutions of metals in liquid ammonia. M. F. DEĬGEN. *Zh. éksper. teor. Fiz.*, **26**, *No.* 3, 293–9 (1954) *In Russian.*

By adopting as a model that the solution is one of metallic impurities, or local electron centres, in a quasi-crystalline ionic dielectric and applying to this the theory of polarons and F and F_2 centres, equations are derived for the variation of the equilibrium concentrations and the magnetic susceptibilities of the local centres with temperature, and thence of the variation of the susceptibility with temperature and metal concentration, which is $C_k = 8{\cdot}93 \times 10^9 T/n^{2/3}$ for alkali metals ($C_k = \chi_a.T$, n = concentration of metal, in atoms/cm^3) and fits the experimental results satisfactorily. R. C. MURRAY

532.73 : 535.343.32 : 541.133

9975. Optical properties and electrical conductivity of solutions of metals in liquid ammonia. M. F. DEĬGEN. *Zh. éksper. teor. Fiz.*, **26**, *No.* 3, 300–6 (1954) *In Russian.*

The model and theory previously used (preceding abstract) are applied to the calculation of the effective mass μ/m of the polarons, and the limiting frequency of vibration ω of the ions in the solution of alkali- and alkaline-earth metals in ammonia, following a suggestion by Davydov [Abstr. 2431 (1949)]. μ/m is found to be 1·28 and $\hbar\omega$ 0·095 eV. The theory fulfils Pekar's criterion that $\hbar\omega \ll \hbar\omega_{1s} \ll \hbar\omega_e$ (ω_{1s} is the frequency for optical transition of electrons from the 1s to the 2p state, and ω_e that of light absorbed by the electrons of the basic substance). Equations are deduced for the dependence of the electrical conductivity, and its temperature coeff., on the concentration of metal in solution. R. C. MURRAY

532.74 : 535.435 : 541.24

9976. Investigation of solutions of linear polymers by light scattering. I. K. Z. FATTAKHOV, V. N. TSVETKOV AND O. V. KALLISTOV. *Zh. éksper. teor. Fiz.*, **26**, *No.* 3, 345–50 (1954) *In Russian.*

The theory is worked out for a method of determining the average molecular weight M and the mean square distance $\overline{h^2}$ between the ends of linear polymer molecules from measurements of the relative intensity of the scattering (in excess of that of the solvent) at an angle of 90° (R_{90}) to the incident beam, and of the asymmetry, R_{45}/R_{135}. The range of values of $\overline{h^2}/\lambda^2$ (λ = wavelength of light used) over which no correction for asymmetry is required is deduced, and the effect of the presence of molecules of differing molecular weight is discussed. R. C. MURRAY

532.74 : 535.435 : 541.24

9977. Investigation of solutions of linear polymers by light scattering. II. Molecular weight and dimensions of molecules of polymethyl methacrylate in acetone. V. N. TSVETKOV, K. Z. FATTAKHOV AND O. V. KALLISTOV. *Zh. éksper. teor. Fiz.*, **26**, *No.* 3, 351–61 (1954) *In Russian.*

The apparatus, based on the theory previously

outlined (see preceding abstract), is described. It is shown that the second virial coeffs. for polymethyl methacrylate fall from $2{\cdot}7\times10^{-4}$ at a molecular weight M of 70 000 to $0{\cdot}9\times10^{-4}$ (cm^3/g.g.-mole) at $M = 6{\cdot}3\times10^6$. The mean values of M and h^2 for the fractions studied are calculated, and a relation between the characteristic viscosity of a sample in benzene and its mean molecular weight is deduced. R. C. MURRAY

532.77 : 535.435 : 535.343.32

Theory of absorption, dispersion and scattering of light by solutions. *See Abstr.* 10045

MECHANICS OF GASES 533

533.1

9978. On the connection between laminar flow of pure gases through tubes and the coefficient of self diffusion. S. WEBER. *K. Danske Vidensk. Selsk., mat-fys. Medd.*, **28**, *No.* 2, 138 *pp.* (1954) *In German.*

Detailed discussion of the theoretical interpretation of experimental work, particularly that of Knudsen (1909). The observed flow G can be represented, for all values of the ratio R/λ = radius of tube/mean free path, by Knudsen's semi-empirical interpolation formula, which consists of 3 independent terms, representing respectively laminar Poiseuille flow (G_3), slip flow (G_2) and flow due to pressure diffusion (G_1), and which predicts that the flow has a minimum for $R/\lambda \simeq 0{\cdot}3$. It is emphasized that measurement of G_1 enables the coefficient of self-diffusion to be determined experimentally. The variation of the 3 terms with R/λ is investigated theoretically by an approximate method, and a formula similar to Knudsen's is obtained. (It is assumed that the cosine law holds for reflection of molecules at the walls of the tube.) The minimum in the flow arises because $G_1 + G_2$ decreases steadily with R/λ, while G_3 increases steadily and reaches its full theoretical value already for $R/\lambda \simeq 0{\cdot}2$ to $0{\cdot}3$. Various methods for determining the coefficient of slip are discussed critically, and an estimate is made of the coefficient of self-diffusion in H_2. The exact theory of pure molecular flow is taken up next, and the variation of flow velocity across a circular cross-section is determined. The influence of occasional collisions between molecules inside the tube is taken into account. Theoretical expressions are derived for G_1 and G_2 in the region of small R/λ; they involve definite integrals whose mathematical properties are studied at length. Detailed comparison between theory and experiment leads to satisfactory agreement over the whole range of values of R/λ. E. H. SONDHEIMER

533.15

9979. The diffusion of gases through polyvinyl acetate. P. MEARES. *J. Amer. Chem. Soc.*, **76**, 3415–22 (*July* 5, 1954).

The diffusion of helium, neon, argon, oxygen and hydrogen through high molecular weight polyvinyl acetate was studied in the temperature range 4–44°. The polymer samples were thin disk membranes cut from mercury cast films and showed no orientation discernible by optical means. The very low permeabilities encountered were measured using a micro-Pirani gauge to minimize the volume of the outgoing side of the diffusion system. Diffusion coefficients were determined using the time-lag method and permeabilities from steady state measurements. Solubilities were obtained from the ratios of these coefficients. Fick's and Henry's laws were accurately obeyed for all the gases over the temperature and pressure range investigated. Logarithmic plots of diffusion, permeability and solubility coefficients against reciprocal temperature show two transition temperatures. The upper one, 26°, is the same for all the gases and corresponds with the usually quoted second-order transition of polyvinyl acetate. The lower one decreases from 18–15° as the molecular size of the diffusing gas increases. The heats of solution of the gases usually reverse sign from negative to positive on entering the transition region from below. The activation energy for diffusion is small over the transition region, and is larger above the region than below it. The results are interpreted in terms of a molecular-kinetic picture of the change in bulk structure of the polymer in passing through the transition region. A.

533.21 : 536.7

9980. Compressibility isotherms of air at temperatures between −25°C and −155°C and at densities up to 560 amagats (pressures up to 1000 atmospheres). A. MICHELS, T. WASSENAAR, J. M. LEVELT AND W. DE GRAAFF. *Appl. sci. Res. A*, **4**, *No.* 5–6, 381–92 (1954).

533.59 : 537.534.3

A mass spectrometer for leak detection. *See Abstr.* 10265

533.6.011.3

9981. On the subsonic flow of a compressible fluid past an axisymmetric slender body. K. KUSUKAWA. *J. Phys. Soc. Japan*, **9**, 605–10 (*July–Aug.*, 1954).

Introducing new variables, the fundamental equation for compressible fluid flow in the hodograph space is reduced to a form similar to that for incompressible fluid flow. Safely neglecting the variation of the shape of an obstacle caused by the transformation, the velocity distribution on the surface of the obstacle can be obtained for the case of compressible fluid flow from the corresponding distribution on the surface of the same obstacle for the case of incompressible fluid flow (which is known theoretically or experimentally). As an example the velocity distributions on the surface of a prolate spheroid with thickness ratio $t = 0{\cdot}1$ are calculated for various Mach numbers and they are compared with the result obtained by the first approximation of the M^2-expansion method. A.

MOLECULAR THEORY OF GASES 533.7

533.7

9982. A difference equation method for the calculation of the probability that two molecules will collide. H. D. LANDAHL. *Bull. math. Biophys.*, **16**, 155–8 (*June*, 1954).

The probability that one molecule will collide with another is calculated for the case in which the molecule is confined to equally spaced rings about the

second larger molecule except when it jumps from one ring to the next. The result is practically the same as that obtained for an infinitesimal mean free path, not having first-order terms in the ratio of the mean free path to the particle radius as does the result of the calculations of Wijsman [Abstr. 3028 (1953)]. A.

533.7 : 530.162

9983. The statistical-mechanical theory of transport processes. VIII. Quantum theory of transport in gases. J. Ross and J. G. Kirkwood. *J. chem. Phys.*, **22**, 1094–103 (*June*, 1954).

For Pt V, see Abstr. 9297 (1951). The quantum-mechanical analogue of the Maxwell–Boltzmann equation of transport in gases of low density is derived from the quantum-mechanical equation for the motion in phase space of the Wigner function. The derivation is based upon the theory of phase-space transformation functions which is developed in this article. Although the present treatment resembles the derivation of Mori and Ono, it is simpler and more general. Particularly, the assumption of random *a priori* phases, an integral part of Mori and Ono's work, need not be applied explicitly. The Uhling and Uhlenbeck equation is verified in the Born collision approximation. A.

533.7 : 533.15 : 539.13

Intermolecular potential as revealed by the study of thermal diffusion of gases. *See Abstr.* 10373

533.7 : 536.423

Statistical theory of phase transition. *See Abstr.* 10130–1

VIBRATIONS . ACOUSTICS 534

534.01

9984. Enumeration of the vibration modes resulting from harmonics or combinations between degenerate vibrations, with special attention to triply degenerate vibrations. C. Duculot. *J. Phys. Radium*, **15**, 644–6 (*July–Aug.–Sept.*, 1954) *In French.*

A general method is described for the determination of the characters of representations associated with harmonics. The formulae derived describe all operations, harmonics and combinations which may occur. A. J. TAYLOR

534.014.5 : 621–233

9985. Forced oscillations in non-linear systems. C. Hayashi. *Osaka: Nippon Printing and Publishing Company* (1953) xiv + 164 *pp.*

Only systems with one degree of freedom are treated; however, a wide variety of oscillations occur in these systems under the influence of periodic external forces. The text is divided into two parts. Pt I, containing four chapters, studies non-linear periodic oscillations in the steady state. Particular attention is directed to the stability investigation of equilibrium states by applying Mathieu's or Hill's equation as a stability criterion. By means of this analysis the stability problem of harmonic, higher harmonic and subharmonic oscillations are discussed in detail. Pt II, consisting of two chapters, deals with the transient state of oscillations which, with the lapse of time, leads to the steady state mentioned above. The geometrical analyses of Poincaré and Bendixson answer this purpose. Thus the transient state of the harmonic and the subharmonic oscillations is investigated by means of geometrical discussion of integral curves. Experimental investigations are described on the use of electrical oscillatory circuits which contain saturable iron cores as the non-linear element, and satisfactory agreement with the foregoing analysis is obtained. A.

534.2

9986. On the propagation of energy in elastic media, N. L. Balazs. Letter in *Proc. Phys. Soc.* [*London*] *A*, **67**, 726–7 (*Aug.*, 1954).

Velocity of propagation (flux/density) of electromagnetic energy within matter is said to have the properties of a particle velocity. Considering the corresponding acoustic problem, the author shows that the velocity of propagation may become infinite relative to some particular frame of reference in distinction to particle velocity and concludes that the concept of a phonon is not Lorentz-invariant. The argument depends, however, on the possibility of bringing the elastic body under high negative pressure which is far beyond the strength of materials.

R. EISENSCHITZ

534.22

9987. Transition temperatures of polymers at ultrasonic frequencies. M. Krishnamurthi and G. Sivarama Sastry. Letter in *Nature* [*London*] **174**, 132–3 (*July* 17, 1954).

As previous experiments gave conflicting results, the variation of longitudinal ultrasonic velocities with temperature in methacrylate and styrene polymers was measured. The method of Krishnamurthi and Balakrishna [Abstr. 5366 (1954)] was applied. Transition temperatures for these velocities were found which were independent of the frequencies applied (70°c for polystyrene, 61°c for polymethacrylate). A. J. TAYLOR

534.22 : 539.32

9988. Determination of ultrasonic sound velocities and elastic constants of solid. I. Takahashi and Y. Ishida. *Mem. Coll. Sci. Univ. Kyoto A*, **27**, 47–54 (*April*, 1953).

An experimental arrangement is described for recording changes in the intensity of an ultrasonic beam transmitted through water when solid plates of different thickness immersed in the water are rotated. From these results, by applying the theoretical work of Rayleigh and Reissner, the velocities of the longitudinal and transverse waves in the solid can be deduced and hence the elastic constants of the solid. Data are given for Al; in general, they do not agree with other recent determinations, such as those of Schneider and Burton. H. J. H. STARKS

534.23

9989. Damping of ultrasound in gels. I. A. M. Srivastava. *Z. Elektrochem.*, **58**, *No.* 4, 241–5 (1954) *In German.*

Develops an expression for the absorption con-

stant of ultrasound in gels as a function of the particle radius, particle concentration (number/volume unit), densities of the liquid phase and of the (spherical) particles. The scattering process has been considered jointly with the viscosity of the medium. The tabulated theoretically obtained values agree well with experimental data. F. LACHMAN

534.23

9990. Damping of ultrasound in gels. II. A. M. SRIVASTAVA. *Z. Elektrochem.*, **58**, *No.* 4, 245–9 (1954) *In German.*

The damping effect was determined for 3 gels ($BaCO_3$, $SrCO_3$ and Fe silicate) at 4 frequencies between 0·625 and 2·5 Mc/s, the temperature varying between 20 and 72°C. It was found that the damping values have maxima at certain frequencies and temperatures. F. LACHMAN

534.23 : 532.7

9991. Absorption of ultrasonic waves in organic liquids. I. Liquids with positive temperature coefficients of sound absorption. T. KISHIMOTO AND O. NOMOTO. *J. Phys. Soc. Japan*, **9**, 620–7 (*July–Aug.*, 1954).

Ultrasonic absorption coefficients have been determined for 12 organic liquids by the pulse technique in dependence of temperature (0° ~ 40°C). The frequency employed was 3·25 Mc/s, 14·5 Mc/s or 20·0 Mc/s. The "frequency-independent" absorption α/ν^2 (α: the absorption coefficient, ν: frequency) at 20°C are as follows (in units of 10^{-17} sec^2/cm): benzene 838, carbon tetrachloride 510, chloroform 406, cyclohexane 503, ethylene chloride 184, chlorobenzene 141, nitrobenzene 86, hexane 80, heptane 55, toluene 94, xylene 81, benzylchloride (13°C) 75. All these liquids proved to have positive temperature coefficient of ultrasonic absorption in the temperature range of 0° ~ 40°C, the absorption increasing about 0·5 ~ 0·6% per degree. Toluene (1·06%/°C) and benzene (0·84%/°C) showed greater temperature coefficients of absorption and carbon tetrachloride and cyclohexane (~ 0·27%/°C) showed lower values of temperature dependence than the other liquids. The chief mechanism of ultrasonic absorption in these liquids is attributed to the thermal relaxation of molecular vibrations, though the absorption due to viscosity amounts to 20% in some of the liquids. The relaxation times of vibrational energy have been computed for three of the liquids, giving $\beta = 3\cdot64 \times 10^{-10}$ sec for benzene, $1\cdot37 \times 10^{-10}$ sec for carbon tetrachloride and $1\cdot51 \times 10^{-10}$ sec for chloroform at 20°C. The activation energies for the deactivation of molecular vibration are of the order of several hundred cal/mol at most for benzene, carbon tetrachloride and chloroform. The exact values of the relaxation time were not to be calculated for other liquids because of the lack of the molecular vibrational data, but they are of the order of 10^{-11} sec. The activation energy is presumably smaller than several hundred cal/mol. A.

534.23 : 539.13

9992. Molecular structure and related problems. Anomalous absorption and dispersion of ultrasonic waves in the critical region. A. ODAJIMA. *Monogr. Res. Inst. Appl. Elect., Hokkaido Univ., No.* 4, 125–39 (1954).

A theory is discussed which explains the increase in absorption of ultrasonics near the critical gas-liquid point; the theory is based on assumptions of heterogeneous arrangements of atoms at this point, which results in a large relaxation time. The anomalous increase in specific heat at the critical point is also discussed on the basis of the hole theory, this latter also gives a larger relaxation time indicating some redistribution of holes. T. C. TOYE

534.24 : 538.566

9993. Certain transmission and reflection theorems. V. TWERSKY. *J. appl. Phys.*, **25**, 859–62 (*July*, 1954).

The well-known relation between the total energy cross-section of a scatterer and its forward scattered amplitude is extended to obtain an approximate transmission coefficient for a uniform planar distribution of parallel cylinders. An analogous reflection theorem for an arbitrary cylindrical boss on a perfectly reflecting plane is then derived; here the total cross-section of the boss is related to the scattering amplitude in the specular direction of reflection of the plane. This is extended to obtain an approximate reflection coefficient for a uniform distribution of cylindrical bosses on a plane. A.

534.3

9994. Theory of the clarinet. R. G. CHATTERJI. *Proc. Nat. Acad. Sci. India A*, **21**, *Pt III–VI*, 261–7 (1952).

Reference is made to the work of R. N. Ghosh [*J. Acoust. Soc. Amer.*, **9**, 255 (1938)] explaining the presence of even harmonics in clarinet tones, which assumed partial closure of the aperture under the reed. McGinnis and Gallagher [*J. Acoust. Soc. Amer.*, **12**, 529 (1941)], however, did not agree with Ghosh's conclusions. By taking continuous motion pictures of the vibration of a section of the reed the author demonstrates the validity of Ghosh's assumption. The paper gives the theory of formation of the even harmonics and shows that the experimental observations support the theory. A. B. WOOD

534.3

9995. Classification of some methods of sound preparation of musical signals. A. MOLES. *Ann. Télécomm.*, **9**, 201–4 (*July–Aug.*, 1954) *In French.*

The structure of musical "signals" can be expressed objectively in the three dimensions—frequency f, amplitude A and time t. From the psychophysical aspect the corresponding quantities are pitch and height H, level L and duration θ. By controlling this three-dimensional relationship the author outlines various ways of "preparing" or transforming the "shape" of any sound signal. These processes provide methods which made it possible to understand the aesthetical properties of the signal. The author suggests that, using the methods he describes, these "preparations" provide a basis for the study of musical signals and the aesthetics and psychology of music and phonetics. A. B. WOOD

534.321 : 612.85

Observation of the Tartini pitch produced by "sin 9x + sin 13x." *See Abstr.* 9863

534.372

9996. Attenuation of short mechanical pulses by high polymers. H. KOLSKY. *Rheology Congress Proceedings*, 79–84 [see Abstr. 10588 (1954)].

The passage of pulses of short duration through a solid polymer, produced by detonators and detected by condenser microphone, is discussed. In soft plastics, such as Polythene, the enhanced velocity of propagation and attenuation of the high-frequency components are important factors in their usefulness as shock-absorbers. J. G. OLDROYD

534.372

9997. Measurements on the damping of flexural vibrations in rods immersed in liquids. E. G. RICHARDSON AND R. I. TAIT. *Österr. Ingen.-Arch.*, **8**, *No.* 2–3, 200–7 (1954).

The decrement of vibrating rods of circular section and of flat reeds due to damping by a liquid ambient medium is measured, using both the Q method and a measurement of the rate of decay. The effects of the form of clamping and the shape of the vibrator are studied. It appears that the decrement in the frequency range up to 600 c/s in a liquid is proportional to its shear viscosity and is not related to the ultrasonic absorption in the same liquid. A.

534.614

9998. A new method of measuring ultrasonic sound velocities in liquids. I. TAKAHASHI, Y. ISHIDA AND M. ÔTA. *Mem. Coll. Sci. Univ. Kyoto A*, **27**, 41–6 (*April*, 1953).

An optical grating is superimposed on the ultrasonic grating produced in the liquid. No change occurs in the diffraction image when the grid constants are equal. By measuring the angle of rotation of the optical grating necessary to produce no change in the image, the grid constant of the ultrasonic grating can be determined, hence the wavelength of the ultrasonic wave. T. C. TOYE

534.7 : 612.85

Physiological acoustics. Hearing. *See Abstr.* 10693

534.845

9999. Acoustic insulation of light structures. J. PUJOLLE AND R. LAMORAL. *Onde Élect.*, **34**, 384–6 (*April*, 1954) *In French.*

A brief account is given of measurements made of the transmission loss of a light panel separating two portions of a chamber, one containing a transmitter and the other a receiver. The panels were of duralumin or compressed wood fibre (Novopan). The transmission loss at different frequencies is given for different thicknesses and arrangements of the materials. H. J. H. STARKS

534.845

10000. Sound absorption by means of cylindrical diffusers. G. PAROLINI. *Ricerca sci.*, **24**, 1465–70 (*July*, 1954) *In Italian.*

Measurements were carried out on the acoustic absorption by cylindrical diffusers made of plywood and coated with porous material. Because of the resonance of the cylindrical plywood framework, a high rate of absorption has been attained also in the low frequencies. The experimental values show a good accord with those computed on the basis of the theory of Cook and Chrzanowsky. A.

OPTICS . RADIATION . SPECTRA 535

535.14 : 535.231.3

10001. On Planck's quantum of action. P. S. EPSTEIN. *Amer. J. Phys.*, **22**, 402–5 (*Sept.*, 1954).

It is shown by means of dimensional analysis that both the Stefan–Boltzmann law and Wien's displacement law imply the existence of Planck's constant of action or of an equivalent constant. A.

535.2.07

10002. A high-speed air-driven shutter for controlling exposures to a convergent beam of high intensity thermal radiation. R. P. DAY, R. L. HOPTON AND A. C. SCHMIDT. *Rev. sci. Instrum.*, **25**, 654–60 (*July*, 1954).

A high-speed two-bladed shutter was built to deliver square-wave pulses of energy from a converging light beam with an average intensity of about 5 cal/cm^2/sec, and a diameter of 3 in., in the plane of the shutter. The blades open or close in less than 0·01 sec. They move in the same direction, so that all parts of the target are exposed for very nearly the same length of time. The shutter makes use of a new type of air cylinder which is suitable for driving high-speed mechanisms, and has a dynamic shock absorbing system to stop the moving parts in a short distance with little rebound. It is electrically controlled and fully automatic. Exposure times may be varied from 0·07 to 5 sec by setting an electronic interval timer. Longer exposures are controlled manually. To date it has been used more than 15 000 times and has required only two overhauls. A.

535.23.08 : 536.627

Calorimeter for measurement of beams of radiant energy. *See Abstr.* 10142

535.233.5

10003. Note on the computation of the alteration of colour temperature by blue filters. W. E. K. MIDDLETON. Letter in *J. Opt. Soc. Amer.*, **44**, 499 (*June*, 1954).

Examines the accuracy with which the colour temperature of the light transmitted through a blue filter can be estimated from the characteristics of the glass, as determined by spectrophotometry. In the case of a particular glass it is shown that for a final colour temperature of about 6500°K (from a gas-filled lamp) an accuracy of $\pm$ 100°K can be obtained only if the absolute accuracy of the photometer approaches 0·001. J. W. T. WALSH

534.24

10004. Image interference in calm, near-isothermal water. F. H. SANDERS. **With an appendix: "Lloyd's Mirror" interference in the presence of slight uniform refraction—an approximate theory.** R. W. STEWART. *Canad. J. Phys.*, **32**, 599–619 (*Sept.*, 1954).

Some experiments are described in which strong image interference of underwater sound has been

observed and measured. These effects occur frequently in coastal British Columbia waters, where calm surface conditions are common, and have been observed at frequencies close to 20 kc/s. The observations are compared with theoretical predictions for small sound velocity gradients and reasonably good agreement obtained. A.

535.244 : 621.383 : 621.317.79

10005. New lightmeter at NTH [Norsk Teknisk Høgskole]. T. ØDMANN. *Elektrotek. T.*, **67**, 248–55 (*June* 15, 1954) *In Norwegian.*

The photometer records automatically the polar diagram of light distribution. The light-source rotates in synchronism with the table on which the record is traced. Circuit diagrams and characteristics of amplifiers and servomotor are given.

J. A. WILCKEN

535.247

10006. The absolute measurement of ultraviolet radiation by means of fluorescent materials. G. FUCHSLOCHER AND G. GLASER. *Z. Phys.*, **138**, *No.* 3–4, 363–71 (1954) *In German.*

An alkaline solution of fluorescein combined with a photomultiplier is used for absolute measurement of 250–400 mμ radiation. G. F. J. GARLICK

535.247 : 771.534.5

10007. An automatically recording densitometer. Å. GRUDEMO. *Appl. sci. Res. B*, **4**, *No.* 1–2, 3–9 (1954).

An instrument for the recording of photographic density distributions is described. It is based on the principle of continuous comparison of the density of points along a line on the moving film and the density of a grey wedge, the position of which is continuously set to balance by means of a servo-system and recorded on a drum. Constructional details of the instrument are described, and the conditions of proper functioning are briefly discussed. A.

535.247.4

10008. Photometric laboratory of to-day's light sources. K. FRANCK AND R. L. SMITH. *Illum. Engng*, **49**, 287–91 (*June*, 1954).

Describes a photometer for determining the light distribution curve of a light source or fitting of large dimensions. A photocell is moved on a track which forms an arc of a circle with the source at its centre. The arc extends from 0° (nadir) to 110°. The source can be raised or lowered and is mounted on a rotator so that it can be set to any required position in azimuth. This setting, and that of the photocell on the track, are controlled by push button from the photometer control room where dials show the positions taken up and the photocurrent given by the cell. This control room is quite separate from the room containing the fitting and photocell. By means of filters the illumination on the cell is limited to 7 lm/ft^2.

J. W. T. WALSH

535.247.4 : 621.317.79

10009. A simple apparatus for the measurement of integrated light. W. HARTNAGEL. *Z. angew. Phys.*, **6**, 310–13 (*July*, 1954) *In German.*

Practical details are given of a modified version of the conventional condenser discharge method of integrating the energy output from an emission (or vacuum gas-filled) photocell. The sensitivity of the method depends *inter alia* on the photocell response, capacitance of measuring condenser, and leakage losses. With a photocell giving an output of 104 μA per lumen from a cathode area of 12·5 cm^2, threshold response is reached with a light-flux of 10^{-6} lumen, the capacitance of the measuring condenser being 83 pF. D. R. BARBER

535.317.3/.6

10010. On the wave aberrations of the decentred lens system with the finite aperture. Y. UKITA AND J. TSUJIUCHI. *J. Phys. Soc. Japan*, **9**, 502–4 (*July–Aug.*, 1954).

First a general formula was obtained for the wave aberrations of the decentred lens system, and then the problem was confined to the axial object point. In addition to the spherical aberration that had inherently existed before decentring, new aberrations were introduced. These new ones were spherical aberration, coma and astigmatism, and of these three coma was the most effective, as the other two were small quantities of higher order. A.

535.321 : 535.417

10011. Spectrointerferometric differential method for measuring the refractive index and dispersion of liquids. D. V. CHEPUR AND A. A. SHISHLOVSKIĬ. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **17**, *No.* 6, 761–4 (1953) *In Russian.*

This is an improvement on Obreimov's (1945) method for determining refractive indices of liquids interferometrically. The construction of a special cuvette for containing the test and reference liquids, the measurement of the thickness of the liquid-containing spaces in the cuvette, using two liquids of known refractive index, the method of determining the absolute value of the order of the interference bands by rotation of the cuvette through a small, accurately measured angle (so as to change the optical thickness of liquid traversed) and finally the method of measuring the refractive index interferometrically to within a few units in the sixth place, are described.

R. C. MURRAY

535.322.4 : 535.242

10012. Visual receiver for the phase contrast refractometer. E. INGELSTAM AND L. JOHANSSON. *Appl. sci. Res. B*, **4**, *No.* 1–2, 100–8 (1954).

The accuracy of a visual photometric meter is limited by the luminance discrimination ratio $\Delta B/B$ of the eye, which, in the present case, is about 2%. The unit, utilizing polarizers, measures optical paths to within 0·003 λ. The efficiency is compared with that of the photoelectric receiver, and accuracy values for some applications, including analyses of the isotope mixtures D_2O^{16}/H_2O^{16} and H_2O^{18}/H_2O^{16}, are given. A.

535.322.4 : 535.247.4

10013. Photoelectric intensity ratio meter as receiver for the phase contrast refractometer. E. DJURLE. *Appl. sci. Res. B*, **4**, *No.* 1–2, 91–9 (1954).

The phase contrast refractometer converts optical phase differences into intensity differences, and thus

the receiver is a photometer. The design described is photoelectric with one phototube and a grey wedge, an electronic device acting as a null indicator. The ratio between the intensities of the two areas to be measured is accurate to 0·3%, corresponding to a difference in optical path in the phase object of 0·0004 λ. A.

535.323 : 535.345

10014. On the dispersion, absorption and thermal emission of zinc oxide crystals. E. MOLLWO. *Z. angew. Phys.*, **6**, 257–60 (*June*, 1954) *In German.*

Refractive indices are measured throughout the visible spectrum by use of a prism with the electric vector parallel and perpendicular to the *c* axis of the crystal ($E\|\|$, 2·00–2·25; $E\perp$, 1·98–2·24); the high dispersion is due to the large absorption in the near ultraviolet. Absorption curves are determined for temperatures 20°–1090°C; the absorption edge moves from ~ 4000 Å to ~ 6000 Å in this range. Emission curves through the visible spectrum are determined by comparison with Pt between 870° and 1090°C and also the total emission at temperatures up to 1330°C. G. F. LOTHIAN

535.33 : 539.132

10015. Quantum faults in the molecular Rydberg series. A. D. WALSH. *J. Phys. Radium*, **15**, 501–2 (*June*, 1954) *In French.*

The principles which rule the values of quantum faults are investigated systematically. Hitherto not enough attention had been paid to (i) the value of n in the formula $\nu = I - \text{constant}/(n-\delta)^2$, (ii) the information which the faults give on the higher orbitals of a series, (iii) the number of intense Rydberg series in a given spectral region. J. JACOBS

535.33.03

10016. On the influence of temperature and pressure on the molecular spectra emitted by mercury vapor. H. TAKEYAMA AND S. HAMAMURA. *J. Sci. Hiroshima Univ. A*, **17**, 239–40 (*Dec.*, 1953).

A brief study of the emission spectra emitted by high voltage a.c. discharges for Hg vapour pressures varying from 7–25 mm Hg. Photographs of the spectra are given. J. D. CRAGGS

535.33.07

10017. Double cell for spectral study of interactions between substances. B. M. MITZNER AND S. Z. LEWIN. Letter in *J. Opt. Soc. Amer.*, **44**, 499–500 (*June*, 1954).

Effectively 2 cells in series, which may be filled with either mixed or unmixed components. G. F. LOTHIAN

535.33.07

10018. Unusual doubling of spectral lines. J. JUNKES AND E. W. SALPETER. Letter in *Nature [London]* **174**, 138 (*July* 17, 1954).

Describes an instrumental doubling of spectral lines, due to prism oscillations, in a certain spectrometer. The effect is analysed mathematically. J. D. CRAGGS

535.33.07

10019. A double-beam spectrophotometer of great dispersion. W.-D. HAGENAH. *Z. angew. Phys.*, **6**, 318–24 (*July*, 1954) *In German.*

Details are given of a precision photoelectric recording spectrophotometer designed for the measurement of line-intensity ratios in emission and absorption spectra. Ratios of up to $10^4 : 1$ may be determined with an accuracy of 1%. D. R. BARBER

535.33.07

10020. A rapid and sensitive recording spectrophotometer for the visible and ultraviolet region. I. Description and performance. C.-C. YANG AND V. LEGALLAIS. *Rev. sci. Instrum.*, **25**, 801–7 (*Aug.*, 1954).

A double-beam recording spectrophotometer has been developed for rapidly obtaining spectra of labile intermediates in biochemical reactions. Light from a monochromator is split into two beams by a chopping mirror and then the ratio of light intensities in two optical paths is measured. This ratio is expressed as per cent absorption or converted electronically into units of optical density. Results are recorded on a linear wavelength scale at a maximum rate of 6 mμ/sec. A servo system corrects the non-linearity of the wavelength scale of the quartz monochromator. The noise level corresponds to a change of optical density of 10^{-4} at 400 mμ with a spectral interval of 3 mμ. The overall accuracy on standard solutions (National Bureau of Standards) is about 2%. The air-against-air zero absorption line varies only 0·004 in optical density from 210 to 650 mμ. A.

535.33.07

10021. A rapid and sensitive recording spectrophotometer for the visible and ultraviolet region. II. Electronic circuits. C.-C. YANG. *Rev. sci. Instrum.*, **25**, 807–13 (*Aug.*, 1954).

The electronic photometer is described in detail. Sources of error of the circuit and experimental measurements of the inherent noise of the systems are discussed. A segmented diode circuit is described for converting data in absorption to units of optical density with an accuracy of better than 1%. The electronic circuit of the servo system to correct the non-linearity of the wavelength scale is also described. A.

535.33.07–14

10022. A high-temperature microwave spectrometer. M. L. STITCH, A. HONIG AND C. H. TOWNES. *Rev. sci. Instrum.*, **25**, 759–65 (*Aug.*, 1954).

A spectrometer for measurement of microwave absorption by gases at temperatures as high as 1000°C is described. Microwaves pass through a 5 ft nickel absorption cell. Absorption lines are modulated by Stark effect to give sensitive detection. The spectrometer has been used to study spectral lines of some alkali halides and several other high boiling point diatomic molecules between 300°C and 775°C. A.

535.33.07–14

10023. Apparatus for microwave spectroscopy. M. W. P. STRANDBERG, H. R. JOHNSON AND J. R. ESHBACH. *Rev. sci. Instrum.*, **25**, 776–92 (*Aug.*, 1954).

Design considerations are presented for a video microwave spectrograph using Stark modulation and a crystal or bolometer detector. Crystal and source noise is explicitly included in the treatment. A detailed description of some of the equipment in use is given. Some of the advantages and disadvantages of other systems are mentioned. A.

535.33.07–15

10024. Twin-beam infra-red spectrophotometer. V. I. Malyshev, M. N. Markov and A. A. Shubin. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **17**, *No.* 5, 654–9 (1953) *In Russian.*

Cf. Abstr. 3280 (1954). Some further details are given about the electronic equipment of the instrument, particularly of the amplifier with a gain of $\sim 10^{10}$, the use of a.c. feed for the bolometer bridge, and the variable aperture slit, to compensate for variation in the intensity of the incident light passed by the monochromator when scanning the spectral region used. R. C. MURRAY

535.33.07–15 : 535.339

10025. Procedure for aligning an infrared monochromator with an off-side concave mirror collimator. E. Kendrick and R. Schnurmann. Letter in *J. Opt. Soc. Amer.*, **44**, 501–2 (*June*, 1954).

A 5-stage adjustment can be completed in 10 min. The resulting resolution of an instrument is indicated by curves for NH_3 and H_2O vapour. G. F. LOTHIAN

535.338/.343

10026. Current problems in the spectroscopy of free radicals. G. Porter. *J. Phys. Radium*, **15**, 497–9 (*June*, 1954) *In French.*

535.338–32

10027. Continuous radiation from the rare gases in the vacuum ultraviolet. C. Kenty. Letter in *J. chem. Phys.*, **22**, 1466–7 (*Aug.*, 1954).

Briefly describes experiments, for example with a phosphor coated probe, which show the emission of continuous radiation in the ranges 1470–2200 Å (Xe), 1066–1300 Å or beyond (A) and 746–1300 Å or beyond (Ne). Discharge pressures varied from 60–120 mm Hg, with a current $\sim$ 1 or 2 mA. J. D. CRAGGS

535.338.332

10028. Hyperfine structure of the spectrum of ruthenium. II. K. Murakawa. Note in *J. Phys. Soc. Japan*, **9**, 427–8 (*May–June*, 1954).

Since Pt I [Abstr. 7559 (1953)] cleaner plates have been obtained which allow an approximate assignation of nuclear magnetic moments to the odd isotopes of Ru I, and of isotope shifts to the even components. G. E. BROWN

535.338.333

10029. The isotope shift in the Ru I spectrum. H. Kopfermann, A. Steudel and H. Thulke. *Z. Phys.*, **138**, *No.* 3–4, 309–16 (1954) *In German.*

The shift is measured for even isotopes for the transitions d^6s^2–d^7p and d^7s–d^7p, giving experimental isotope shift constants such as one might expect from other experiments on elements in the neighbourhood of Ru. G. E. BROWN

535.338.334

10030. Statistical theory of the effect of pressure on spectral lines. II. R. Bergeon. *C.R. Acad. Sci. [Paris]* **238**, 2507–10 (*June* 28, 1954) *In French.*

For Pt I, see Abstr. 119 (1953). These calculations take account of the repulsive forces in the displacement and broadening of atomic lines under high pressure. The absorption probabilities are calculated treating the statistical effect of N perturbations as a Markoff process. J. JACOBS

535.343 : 535.375.5

10031. Spectral study of hydrofluoric acid. E. Safari. *Ann. Phys.* [*Paris*] **9**, 203–54 (*March–April*, 1954) *In French.*

The absorption of gaseous HF in the middle ultraviolet and in the Schumann region, and the effect of temperature on the absorption in the latter region have been determined. The Raman effect and the infrared absorption of the liquid acid has also been investigated. At least up to a thickness of 225 cm and at 760 mm pressure, HF gas is completely transparent in the middle and near ultraviolet. In the Schumann region there is a region of relatively weak absorption starting at 1650 Å and extending towards shorter wavelengths. The potential energy curve of the excited state has been obtained and the energy of dissociation deduced from it is in agreement with thermodynamic values. The effect of temperature on the absorption in this region gives results which differ from those obtained for the other halogen acids; it is probable that even at 100° some of the molecules are associated. The Raman spectrum of the liquid acid agrees with that obtained by former workers. The absorption spectrum of the liquefied acid has been studied between 0·95 and 4·25 μ. Four bands were found with max. at 9950, 5220, 4150 and 3078 cm^{-1}. In liquid HF the associated structure is very similar to that in the gas at 20° and atmospheric pressure, the fundamental bands due to association and to the monomer being almost the same in form and intensity in the two cases. The structure of the group FHF in the liquid is very different from that of the same group in KHF_2. In the gaseous state the structure is very probably unsymmetrical. The liquid must contain a small concentration of unperturbed HF mols. The degree of association is not markedly increased by condensation to the liquid state. A. J. MEE

535.343–31

10032. Hidden transitions in the absorption bands of stilbene in the near ultraviolet. R. N. Beale and E. M. F. Roe. *J. Phys. Radium*, **15**, 595–8 (*July–Aug.–Sept.*, 1954) *In French.*

An attempt is made to classify the three bands between 200 and 350 mμ of stilbene and its derivatives and the corresponding bands of benzene are given with the ε-values. C. TURNER

535.343.2

10033. Connection between the absorption spectra of the excess metals and the lattice type of the main substance. P. N. Kokhanenko. *Zh. éksper. teor. Fiz.*, **26**, *No.* 1, 120–3 (1954) *In Russian.*

See also Abstr. 8319 (1953). It is shown that the absorption spectra of particles (atoms or ions) of the excess metals (Cu, Zn, Cd, Ag, Ni) in substances with the co-ordination number four [$CuCl(CuCl_2)$, CuI, AgI, $AuCl_3(AuCl)$ and ZnO] differ substantially from those of the same particles in substances with the co-ordination number six (AgBr, AgCl, ZnI_2, $ZnCl_2$, CdI_2, $CdBr_2$ and $NiCl_2$). The former display very intense absorption bands with a small half-width (20–50 Å); in the latter, the bands are broad and diffuse, their width being several hundreds of Å. F. LACHMAN

535.343.2 : 548.7

10034. Absorption spectrum and symmetry of single crystals of EuZn nitrate. K.-H. Hellwege and W. Schröck-Vietor. *Z. Phys.*, **138**, *No.* 3–4, 449–58 (1954) *In German.*

The absorption spectrum of the Eu^{+++} ions in single crystals of $Eu_2Zn_3(NO_3)_{12} \sim H_2O$ was taken in polarized light with a grating spectrometer at temperatures ranging from 14 to 293°K. On the basis of the orientations of the electrical and magnetic dipoles in the crystal which are active in the transition $^7F_0$–$^5D_{0\cdot12}$ the point group of the Eu^{+++} ions was determined as Cs and the probable symmetry group of the monoclinic crystal as C'_{2h}. The values of the crystal quantum number were also determined for the term components. From the orientation of the magnetic dipoles the eigenstates of the components were found to be $^5D_1$. The dependence of the spectrum upon temperature will be dealt with in a later paper. A. J. TAYLOR

535.343.2–15

10035. Interpretation of the vibration spectra of silicates and silicate glasses. V. A. Kolesova. *Zh. éksper. teor. Fiz.*, **26**, *No.* 1, 124–7 (1954) *In Russian.*

Discussion paper. The interpretation suggested by Matossi and co-workers [*Z. Phys.*, **89**, *No.* 3–4, 210–33 (1934); **108**, *No.* 5–6, 295–313 (1938)] and based on the vibrations of the isolated tetrahedral SiO_4 group is considered to be unsatisfactory. Such a treatment is claimed to be permissible only in the case of lattices of molecular crystals or ionic lattices of the $NaNO_3$ type (with discrete radicals), but not for quartz or silicates, where the spectrum of individual vibrations should be determined by vibrations of the elementary lattice. Besides this theoretical aspect, the four individual frequencies of the tetrahedral molecules can explain only a small part of the experimentally determined infrared frequencies.

F. LACHMAN

535.343.2–15

10036. Some observations on the infrared spectra of normal paraffins in the crystalline state. J. K. Brown, N. Sheppard and D. M. Simpson [Mrs. J. N. Agar]. *J. Phys. Radium*, **15**, 593–5 (*July–Aug.–Sept.*, 1954) *In French.*

Rocking of CH_2 is proved by the infrared absorption band series for propane up to nonadecane. A series of bands originating from wagging of CH_2 has been observed in the propane absorption spectrum. The bands due to twisting are not adequately resolved.

C. TURNER

535.343.2–15 : 548

10037. Infrared spectrum and longitudinal and transversal waves in cubic crystals. M. M. C. Haas and J. P. Mathieu. Letter in *J. Phys. Radium*, **15**, 492–4 (*June*, 1954) *In French.*

The Fröhlich relation $(\nu_l/\nu_t)^2 = \varepsilon/n_0^2$ can be used for reflection spectra for zero damping. For a finite damping a formula to calculate Raman frequencies from reflection spectra can be found. Experiments on ZnS give $\nu_l = 367\ cm^{-1}$ (for $\nu_t = 286\ cm^{-1}$). Transmission spectra through thin crystalline layers should have a minimum between ν_l and the frequency of the maximum reflection. Experiments on a thin layer of ZnS gave a minimum at $\nu = 274\ cm^{-1}$ agreeing with the diffusion and reflection values.

C. TURNER

535.343.2–31

10038. Broadening of the absorption band of heated silvered NaCl crystals. W. van der Vorst and W. Dekeyser. Letter in *Naturwissenschaften*, **41**, *No.* 12, 279–80 (1954).

When warmed up to 150°c an absorption band is seen in near u.v. whose edge varies from 2400 Å to 2100 Å with increasing thickness of Ag layer. Maxima found at 1850, 2090 and 1865 Å. [See also Abstr. 7823 (1954).] J. EWLES

535.343.3–14

10039. Microwave absorption in the mixture (phenyl isothiocyanate + diethylamine). P. K. Kadaba. Letter in *J. chem. Phys.*, **22**, 1465–6 (*Aug.*, 1954).

This mixture shows a minimum of ε'' at 14 200 Mc/s for a 50/50 mixture at which composition the viscosity shows a very sharp maximum. D. H. WHIFFEN

535.343.3–15

10040. Infrared absorption of liquid water from 2 to 42 microns. E. K. Plyler and N. Acquista. Letter in *J. Opt. Soc. Amer.*, **44**, 505 (*June*, 1954).

In order to investigate how long-wave radiation is transmitted through water in animal tissue at body temperature, the spectrum of water layers of thickness 0·005, 0·01, and 0·03 mm was taken in this region. The transmission graphs are reproduced. One broad band at 15·5 μ does not appear in the vapour spectrum and is attributed to intermolecular vibrations. A. J. TAYLOR

535.343.3–15

10041. Infrared absorption spectrum of derivatives of benzoquinone. P. Souchay, Tatibouët and P. Barchewitz. *J. Phys. Radium*, **15**, 533–5 (*June*, 1954) *In French.*

The spectra of a large number of quinones were taken in the region 650 to 1650 cm^{-1}. The C = O vibration was investigated. For quinone and other molecules of the same symmetry the symmetric valence band is forbidden. The anti-symmetric vibration occurred at 1650 cm^{-1}, which is shifted to lower frequency with respect to ketones. This suggests pure double and single bonds in the rings. In molecules with lower symmetry the symmetric vibration becomes active. This was found for some molecules near 6 μ, though for others it could not be observed. Some bromine and nitro compounds were also investigated. A. J. TAYLOR

535.343.3–15

10042. An anomaly in the infrared absorption spectra of some para-dialkyl benzenes. C. La Lau. *J. Phys. Radium*, **15**, 623–5 (*July–Aug.–Sept.*, 1954) *In French.*

In the spectra of most para-di-substituted benzenes there appears one band between 780 and 850 cm^{-1} attributed to the wagging vibration of the substituents out of the molecular plane. Here a number of such compounds is studied with substituents ranging from ethyl to hexadecyl groups. Most of these present two or more maxima of absorption in this region. Increase in lengths of the substituent chains causes

these bands to broaden and flatten, so that the largest compound presents a general absorption with an ill-defined maximum. It is suggested that two different types of molecules, rotational isomers, coexist, which have different maxima for the wagging vibration. Additional evidence for this suggestion is given by the liquid and solid spectra of para-dihexadecyl benzene, where the spectrum of the quickly solidified liquid differs strongly from both liquid crystalline spectra. A. J. TAYLOR

535.343.32

10043. Absorption spectra of dyes in solution. Y. Ooshika. *J. Phys. Soc. Japan*, **9**, 594–602 (*July–Aug.*, 1954).

A theory of absorption spectra of dyes in solution is presented. The wave-number shift of the absorption maximum is calculated using perturbation theory, where the distribution of solvent molecules is assumed to be uniform, and the shift is represented by experimentally convenient quantities, such as the dielectric constant, the refractive index, and the absorption wavelength of the solvent. The solvent effects are classified into several groups, and the theory can explain the various experimental facts successfully. Previous theories are criticized. A.

535.343.32

10044. Spectroscopic investigations into the influence of an oxidizing agent on the extraction of a sulphuric lignin. J. Guillemain-Gouvernel. *J. Phys. Radium*, **15**, 648–9 (*July–Aug.–Sept.*, 1954) *In French.*

Samples of beech have been treated with oxygenized water or with H_2SO_4, and the spectrum is measured from 800 to 1600 cm^{-1} and compared with that of a solution of lignin. The oxidation products are very different in structure from lignin, but seem still to contain a benzene ring. C. TURNER

535.343.32 : 535.435 : 532.77

10045. Theory of absorption, dispersion and scattering of light by solutions. A. S. Davydov. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **17**, *No.* 5, 523–30 (1953) *In Russian.*

Mathematical. General equations are derived for the effect of a solvent (conceived as a crystalline solid) on the form of an absorption band of a dissolved substance, and for the dependence of the probability of scattering of light on its frequency and the dispersion curve, and are then applied to strong and weak interaction of an electronically excited molecule of the solute with lattice vibrations of the solvent.

R. C. MURRAY

535.343.32–31

10046. The ultraviolet absorption spectrum of *p*-amino-salicylic acid. R. F. Rekker. *J. Phys. Radium*, **15**, 620–2 (*July–Aug.–Sept.*, 1954) *In French.*

Gives absorption curves for this, its thio-derivative and salicylic acid in alcohol and water at various pH values. Changes with pH are attributed to dissociation of the molecule. The characteristics of the spectra are discussed qualitatively from the point of view of the chromophores present. G. F. LOTHIAN

535.343.4

10047. Probability of radiationless transitions in the predissociational region of molecular spectra. N. A. Prilezhaeva and V. I. Danilova. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **17**, *No.* 6, 671–4 (1953) *In Russian.*

The intensity distribution in the absorption spectrum of SO, produced by a condensed discharge in SO_2 at 1–15 mm Hg pressure, agrees with that calculated from the Frank–Condon principle for transitions from the ground, to the first vibrational, level, but there are large divergences for transitions to the 2nd and particularly the 3rd level (close to the predissociational region). This is explained by an increase in the number of radiationless transitions into an unstable state, which may be regarded as an increase of the tunnel effect, and an attempt is made to calculate the probability of such transitions.

R. C. MURRAY

535.343.4–14

10048. Spectroscopy from 1 to 5 mm wavelength. W. Gordy. *J. Phys. Radium*, **15**, 521–3 (*June*, 1954) *In French.*

A review of the experimental methods and the results obtained at Duke University. D. H. WHIFFEN

535.343.4–14

10049. Spectrum of ethylamine $C_2H_5NH_2$. M. Matricon and Bonnet. *J. Phys. Radium*, **15**, 647–8 (*July–Aug.–Sept.*, 1954) *In French.*

This was measured between 22 100 and 26 000 Mc/s. A list of lines is given. A demountable klystron was used and a description is given of the method of measurement. C. TURNER

535.343.4–14

10050. Temperature dependence of microwave absorption coefficient. Krishnaji and P. Swarup. Letter in *J. chem. Phys.*, **22**, 1456–7 (*Aug.*, 1954).

Maintains that the line breadth parameter $(\Delta\nu)_{av}$ varies as $T^{-1/2}$ for NH_3 in accordance with a hard sphere kinetic theory (see next abstract).

D. H. WHIFFEN

535.343.4–14

10051. Temperature dependence of the microwave absorption of NH_3. G. Birnbaum and A. A. Maryott. Letter in *J. chem. Phys.*, **22**, 1457 (*Aug.*, 1954).

See preceding abstract. A reply maintaining that their data [Abstr. 292 (1954)] indicates a T^{-1} dependence. D. H. WHIFFEN

535.343.4–14

10052. Direct *l*-doublet transition of HCN in the 10-centimeter wavelength region. R. J. Collier. *Phys. Rev.*, **95**, 1201–2 (*Sept.* 1, 1954).

A variable-frequency, Stark-modulation, resonant-cavity spectrometer was developed for spectroscopy in the 10 cm spectral region. The direct *l*-doublet transition of HCN for $J = 3$ and $v_2 = 1$ was measured to be $\nu_0 = 2693{\cdot}21 \pm 0{\cdot}08$ Mc/s, with an absorption coefficient determined to be $\alpha = 3 \times 10^{-8}$ cm^{-1}. A.

535.343.4–14 : 539.132

10053. Microwave spectrum of ethyl chloride. R. S. Wagner and B. P. Dailey. Letter in *J. chem. Phys.*, **22**, 1459 (*Aug.*, 1954).

Rotational and quadrupole coupling constants are given and discussed. The C–Cl bond is more ionic than in CH_3Cl. The torsional frequency is 215 cm^{-1} and the barrier height 3000 cal. D. H. WHIFFEN

535.343.4–15

10054. Infrared spectrum of hydrogen sulfide. II. The 5100 cm^{-1} region. H. C. Allen, Jr and E. K. Plyler. *J. chem. Phys.*, **22**, 1104–7 (*June*, 1954).

For Pt I, see Abstr. 7307 (1954). The absorption of hydrogen sulphide in the region near 2 μ has been measured under high resolution. The rotational fine structure has been analysed with the use of published energy tables for the rigid rotor. A classical centrifugal distortion correction was applied to the rigid rotor energy levels. The absorption can be accounted for by three bands plus overlapping water-vapour absorption. The three bands are the $(n_1, n_2, n_3) = (1, 0, 1)$ at 5147·36 cm^{-1}, the (0, 2, 1) at 4939·23 cm^{-1}, and the lower component of the resonating pair (2, 0, 0) and (0, 0, 2) at 5145·12 cm^{-1}. The excited-state inertial parameters in cm^{-1} giving the best fits are

	A^*	B^*	C^*
(1, 0, 1)	10·076	8·709	4·608
(2, 0, 0)	10·059	8·719	4·612
(0, 2, 1)	10·871	9·332	4·562

With the location of the (0, 2, 1) band it is possible to place the (0, 0, 1) band at 2628 cm^{-1}. A.

535.343.4–15

10055. Infrared absorption of hydrogen under high pressures. D. A. Chisholm, W. F. J. Hare and H. L. Welsh. *J. Phys. Radium*, **15**, 511–12 (*June*, 1954) *In French.*

The infrared absorption of H_2–He and H_2–N_2 mixtures in the frequency range 3500–5500 cm^{-1} at 1500 and 5000 atm. respectively is given in graphical form and discussed. G. I. W. Llewelyn

535.343.4–15

10056. Measurement of the intensity and of the width of absorption lines in the infrared. Application to carbon monoxide. J. Vincent-Geisse. *J. Phys. Radium*, **15**, 539–40 (*June*, 1954) *In French.*

Using a theoretical treatment, a formula is deduced for the relationship between absorption frequency and intensity. This formula is tested by measurements on CO and CO–air mixtures. G. I. W. Llewelyn

535.343.4–15

10057. Study of the 2 ν_3 band of nitrous oxide at 2·26 μ. G. Amat, P. Barchewitz and M.-L. Grenier-Besson. *J. Phys. Radium*, **15**, 563–7 (*July–Aug.–Sept.*, 1954) *In French.*

This band at 4417 cm^{-1} was analysed by comparison with the fundamental ν_3, the frequencies of which are accurately known. Constants occurring in the formula for the vibration energy and rotational constants, determined previously, were used for the calculation of the band frequencies. The constants ω_3^0 and x_{33} could be calculated with precision from the spectrum taken. A. J. Taylor

535.343.4–15

10058. On the infrared absorption induced in CO_2 under pressure. J. Fahrenfort, H. de Kluiver and T. P. J. H. Babeliowsky. *J. Phys. Radium*, **15**, 617–20 (*July–Aug.–Sept.*, 1954) *In French.*

Several of the infrared absorption lines, normally forbidden but induced by collisions, have been investigated and the intensities found approx. $\propto$ (density)^2, as is expected. Reasons are discussed why some of these lines now found, which are permitted in the Raman spectrum, have not so far been observed there. G. F. Lothian

535.343.4–15

10059. The vibration-rotation spectrum of nitrous oxide. G. Amat. *J. Phys. Radium*, **15**, 636–8 (*July–Aug.–Sept.*, 1954) *In French.*

This spectrum was taken in the region 5–1·5 μ. Between 2·5 and 1·5 μ 11 bands were observed, 9 parallel and 2 perpendicular. Fine structure could not be observed. Between 5 and 2·5 μ one more band was found, but this was partially overlapped by an atmospheric water band. The assignment of the bands is given. A. J. Taylor

535.343.4–15

10060. Perturbation of some infrared absorption frequencies and by gases compressed to pressures of the order of 1000 atm. R. Coulon, L. Galatry, B. Oksengorn, S. Robin and Vodar. *J. Phys. Radium*, **15**, 641–3 (*July–Aug.–Sept.*, 1954) *In French.*

Normally forbidden rotation-vibration bands of H_2, N_2 and CO_2 can be observed if the gas is kept under high pressure. The contours of the bands are independent of the pressure, but the absorption is proportional to ρ^2, ρ being the density of the gas. The 2331 cm^{-1} band of N_2 and the 1556 cm^{-1} band of O_2 were studied. The proportionality is found at all pressures for N_2, but for O_2 the absorption is somewhat too small at high pressures. The spectrum of HCl was studied with N_2 and A as compressing gases, the partial pressure of HCl varying between 0·5 and 1 atm. Here also the absorption is not quite proportional to ρ^2 with either compressing gas. Compared with previous experiments N_2 and A perturb the HCl bands more than H_2 or He. A theoretical explanation is given of this effect. A. J. Taylor

535.343.4–15 : 539.132

10061. The infrared spectrum and the molecular constants of sulphuric anhydride. A. H. Nielsen, R. D. Shelton and W. H. Fletcher. *J. Phys. Radium*, **15**, 604–7 (*July–Aug.–Sept.*, 1954) *In French.*

A new observation of the spectrum between 450 and 5500 cm^{-1} with the special object of resolving ν_3 and obtaining the maximum number of harmonic and combination bands. The rotational constants determined from an analysis of ν_1, ν_2, ν_3, 2ν, $\nu_1 + \nu_3$, $\nu_2 + \nu_3$ are in good agreement with those found from microwave data. J. Jacobs

535.343.4–15 : 539.132

Infrared absorption bands of the molecule CD_3–CD_2H. *See Abstr.* 10388

535.343.4–32

10062. Effect of pressure on intensity of some electronic transitions in SF_6, C_2H_2 and C_2D_2 vapors in the vacuum ultraviolet region. E. D. Nostrand and A. B. F. Duncan. *J. Amer. Chem. Soc.*, **76**, 3377–9 (*July* 5, 1954).

The absolute intensities of four separate electronic transitions of SF_6 in the region 1850 to 780 Å have been measured quantitatively by methods of photographic photometry. Three of these transitions were fitted to a Rydberg series with an ionization limit of

16·15 eV. Experimental *f*-numbers for these transitions were found, and *f* for the lowest energy transition was compared with a value calculated with approximate wave-functions. The effect of rotational structure of electronic transitions on the integrated absorption coefficients was studied for part of this transition. This effect was studied also for a transition near 65 800 cm^{-1} in C_2H_2 and in C_2D_2. The same experimental *f*-number was found for both molecules, and the value was independent of the pressure. A.

535.343.4–32

10063. The absorption spectra of gaseous SiO, GeO, SnO, SnS and AlF in the Schumann region. R. F. Barrow and H. C. Rowlinson. *J. Phys. Radium*, **15**, 499–500 (*June*, 1954) *In French.*

535.354 : 539.153.4

10064. New measurements of the duration of luminescence of excited atoms. M. Ardenne. *Zh. éksper. teor. Fiz.*, **26**, *No.* 3, 362–6 (1954) *In Russian.*

The experimental arrangement is an improvement of Wien and Atkinson's technique (1927). The lifetime for the H_β line in the excited state is in better agreement with calculations done by classical electrodynamics than by quantum mechanics. J. JACOBS

535.37

10065. Effect of the quenching elements Fe, Co and Ni on luminescence of the ZnS phosphors. F. I. Vergunas and Yu. M. Salchenko. *Zh. éksper. teor. Fiz.*, **24**, *No.* 4, 470–7 (1953) *In Russian.*

Presents results of an investigation on luminescent properties of the phosphors ZnS–Zn, ZnS–Cu and ZnS–Mn, both "poisoned" and not "poisoned" by the killer centres Fe, Co and Ni. It has been found that the temperature quenching of the poisoned phosphors is, as a rule, identical with that of the pure phosphors. In both cases, the process of quenching is independent of recombinations, i.e. the quenching is an external phenomenon, and its energy of activation can vary without a corresponding displacement of the emission spectra and of the edge of the zone of fundamental absorption. The hole-migration theory [see Abstr. 1815 (1948)] has been used as the basis for explaining the quenching process; some use has also been made of Adirovich's theory [see Abstr. 9119 (1954)] according to which the process of recombination of the free electrons with the killer centres must be activated thermally. F. LACHMAN

535.37

10066. Intensity of luminescence of powder luminophors. A. P. Ivanov. *Zh. éksper. teor. Fiz.*, **26**, *No.* 3, 275–80 (1954) *In Russian.*

A theoretical discussion of the dependence of the intensity of luminescence of powders on the degree of dispersion, binding medium and thickness of layer. On the assumption that absorption, scattering and emission follow continuous functions of thickness, expressions are obtained for the emission on the excited side and opposite side, and the optimum thickness is determined. J. EWLES

535.371

10067. On the infrared-sensitive behaviors of some doubly activated ZnS phosphors. S. Asano. *J. Phys. Soc. Japan*, **9**, 580–94 (*July–Aug.*, 1954).

The quenching and stimulation of phosphorescent brightness under infrared irradiation, and their spectral sensitivities about some ZnS doubly activated phosphors, have been investigated as well as the photocurrents induced simultaneously. A model is proposed which contains two types of electron traps, namely traps associated with emission levels at the activator and isolated traps. Theoretical calculations based on this model are compared to the experimental results for non-stationary behaviour. The comparison shows that non-radiative transitions from the conduction band to the filled band, and so-called infrared-sensitive "quasi-direct transitions" from the associated traps to the activators become negligible a few minutes after ultraviolet excitation ceases, and then the proposed theory becomes exactly applicable. A.

535.371

10068. Phosphorescence of atoms and molecules of solid nitrogen at 4·2°K. H. P. Broida and J. R. Pellam. Letter in *Phys. Rev.*, **95**, 845–6 (*Aug.* 1, 1954).

A green glow was observed on the walls of a helium-cooled trap receiving nitrogen passing through an electrodeless discharge system. The glow decayed slowly after cessation of discharge and nitrogen flow. It was accelerated by warming, and a blue glow appeared before final extinction. The observations suggest that in the solid phase atoms co-exist with molecules. G. F. J. GARLICK

535.371

10069. Anisotropy of fluorescence of some organic crystals. S. C. Ganguly and N. K. Chaudhury. *Phys. Rev.*, **95**, 1148–52 (*Sept.* 1, 1954).

A mathematical relationship between the intensities of polarized fluorescence in different perpendicular directions and the molecular orientations with respect to the crystal axes has been established, and particular reference is made to the plane aromatic molecules. It is emphasized that the knowledge of intensities of polarized fluorescence in different directions of a crystal may, in favourable cases, give direct information regarding the orientation of the molecule and the nature of oscillators responsible for giving fluorescent light. A.

535.372

10070. Photoluminescence of copper halides. K. V. Shalimova and H. C. Mendakov. *Zh. éksper. teor. Fiz.*, **26**, *No.* 2, 248–53 (1954) *In Russian.*

A study of luminescence spectra, which are shown to have a connection with the stoichiometric excess of copper. The results support the hypothesis that the effects are due to transitions in copper atoms whose levels are modified by crystal lattice fields. J. EWLES

535.375.5

10071. Width of Raman lines in a vapour. I. I. Sobel'man. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **17**, *No.* 5, 554–60 (1953) *In Russian.*

It is shown mathematically that the Raman lines for benzene and cyclohexane at 1–2 atm., are so much wider than would be expected, on the basis of gas-kinetic collisional cross-sections (Storin, 1950), because of interaction of vibrational and rotation states, and not because of intermolecular action. The pressure dependence of the line form and width for

vibrations of different types, at high pressures, is discussed. R. C. MURRAY

535.375.5

10072. Translational frequencies of molecular crystals from Raman spectra. F. I. SKRIPOV. *Izv. Akad. Nauk SSSR, Ser Fiz.*, **17**, *No.* 5, 592–5 (1953) *In Russian.*

Calculations of the frequencies of translational lines in the spectrum of CO_2, using a value of $2{\cdot}1\times10^{-3}$ dyne/cm for K, the quasi-elastic constant, derived from the volume compressibility, yield an average (over the various possible forms of translational motion) of 65 cm^{-1}, whereas a value of $3{\cdot}8_8\times10^{-3}$, from rotational frequencies, yields 88 cm^{-1}, and 90 cm^{-1} is obtained from analysis of the thermal capacities of crystalline CO_2 at low temperatures; these figures are all somewhat greater than the frequencies of rotational lines and show the incorrectness of neglecting translational motions in the analysis of spectra, on the grounds that they can only give rise to lines of low frequency. A value of 115 cm^{-1} is calculated for the translational frequency of d-tartaric acid, by an extension of the method used for CO_2. R. C. MURRAY

535.375.5 : 539.132

Studies on molecular structure by the Raman effect. *See Abstr.* 10405

535.375.56

10073. High resolution Raman spectroscopy of gases. C. CUMMING, E. J. STANSBURY AND H. L. WELSH. *J. Phys. Radium*, **15**, 615–16 (*July–Aug.–Sept.*, 1954) *In French.*

A review. To obtain adequate intensity a high current, water-cooled Hg lamp is used with a multiple-reflection Raman tube. Pressure broadening of Raman lines (up to 1 cm^{-1}/atm) is being investigated. G. F. LOTHIAN

535.376

10074. Electroluminescent ZnS phosphors. P. ZALM, G. DIEMER AND H. A. KLASENS. *Philips Res. Rep.*, **9**, 81–108 (*April*, 1954).

In Pt I, an account is given of the preparation of electroluminescent zinc-sulphide powders. The preparation is based on the assumption that a copper-rich layer on the surface of the grains is necessary for electroluminescence. In Pt II, electrical and optical measurements on electroluminescent ZnS powders are described, including various oscillograms of suspended and binderless settled layers, and stroboscopic observation of the individual crystals by means of a microscope. The maximum efficiency is $1{\cdot}5\ (\pm0{\cdot}2)$ lm/W; the brightness at 600 V, 3000 c/s is about 1000 lm/m^2. The hypothesis of a barrier action at the surface of the grains is confirmed. In Pt III, the observations of Pts I and II lead to the conclusion that electroluminescence is a kind of cathodoluminescence with "slow" electrons. The smallness of the efficiency of electroluminescent phosphors is compared with that of normal phosphors under cathode-ray excitation at low voltage and high current density. A discussion is given of an equivalent circuit for a suspended electroluminescent layer. A.

535.376

10075. The effect of alternating electric fields on the excitation of a strontium sulphide phosphor. W. LOW, J. T. STEINBERGER AND E. A. BRAUN. Letter in *J. Opt. Soc. Amer.*, **44**, 504–5 (*June*, 1954).

A SrS–Eu–Sm phosphor excited when in an applied alternating electric field shows an enhanced stimulation by infrared light. The effect increases with duration of excitation in the field. It is still noticeable some hours after cessation of excitation but subsequent excitation in the absence of a field removes the effect. G. F. J. GARLICK

535.376

10076. Experiments on electroluminescence. J. F. WAYMOUTH AND F. BITTER. *Phys. Rev.*, **95**, 941–9 (*Aug.* 15, 1954).

A summary of recent observations of the properties of ZnS : Cu : Pb and ZnS : Cu : Pb : Mn electroluminescent phosphors is reported. The experiments include studies of the optical and electrical response of these phosphors dispersed in "Lucite" to sudden changes in a constant applied field, as well as microscopic studies of the luminescence of individual particles. Both green and yellow phosphors were studied. The most important results observed primarily on green phosphors are the following: Slow changes are found to take place in a phosphor in any given constant electric field, but a steady state is finally approached. A sudden departure from this state produced by changing the applied field will in general produce very little light compared to that produced on returning promptly to the conditions under which the steady state was established. Further, the luminescence in alternating electric fields of individual grains is extremely inhomogeneous, being restricted to small "pinpoints" or "spots" very much smaller than the individual particles. The spots studied luminesced only once per cycle. It is concluded that excitation of luminescent centres occurs primarily by ionization, with recombination and radiation occurring when subsequent electrical changes make this possible. Although excitation of luminescent centres to bound states followed by prompt radiation does occur, under the conditions of these experiments this process is of secondary importance in producing light in all the phosphors studied, and is quite negligible in the green phosphors. These and other results are discussed in connection with the several possible mechanisms by which electric fields may bring about the excitation of luminescent centres. A.

535.376 : 535.247.1

10077. A simple photographic method for the measurement of the luminous flux emitted by small specimens of fluorescent salts excited by the radiations produced by radioactive isotopes. G. PAROLINI. *Ricerca sci.*, **24**, 1238–45 (*June*, 1954) *In Italian.*

The method permits measurement of luminous fluxes of the order of 10^{-6} lumens. A.

535.39

10078. A contribution to the study of the selective reflection of mercury resonance radiation from mercury vapour. J.-L. COJAN. *Ann. Phys.* [*Paris*] **9**, 385–440 (*July–Aug.*, 1954) *In French.*

A detailed experimental and theoretical study of the reflection of u.v. radiation (2537 Å) from mercury vapour, over a pressure range varying from about 1 or 2 to nearly 1000 mm Hg. The radiation was

filtered optically (using essentially Mrozowski's "magnetic filter") so as to be nearly monochromatic. Details of the various optical systems are given. There is a long theoretical section. J. D. CRAGGS

535.393

10079. The temperature dependence of the optical constants of copper, silver and gold down to 20°K. G. Joos and A. Klopfer. *Z. Phys.*, **138**, *No.* 3–4, 251–65 (1954) *In German.*

Measurements from 20 to 428°K are reported. There are two bands, one at long wavelengths, in the visible region for Cu and Au, and one in the ultraviolet. The results are interpreted in some detail. The long-wave peak is attributed to the transition $(n-1)d^{10}ns \rightarrow (n-1)d^{9}ns^{2}$, and the shorter wavelength one to $ns \rightarrow np$. In copper and gold the two overlap but in silver they are distinct. The shape of the temperature broadening of the Fermi surface and its variation with temp. can be seen. n_K as function of temperature shows a sharp kink at the Debye temp. for the long-wave band, and a smoother variation for the shorter wavelength band. W. M. LOMER

535.4

10080. A macroscopic theory of interference and diffraction of light from finite sources. I. Fields with a narrow spectral range. E. Wolf. *Proc. Roy. Soc. A*, **225**, 96–111 (*Aug.* 6, 1954).

A macroscopic theory of interference and diffraction of light in stationary fields produced by finite sources which emit light within a finite spectral range is formulated. It is shown that a generalized Huygens principle may be obtained for such fields, which involves only observable quantities. The generalized Huygens principle expresses the intensity at a typical point of the field in terms of an integral taken twice independently over an arbitrary surface, the integral involving the intensity distribution over the surface and the values of a certain correlation factor, which is found to be the "degree of coherence" previously introduced by Zernike. Next it is shown that under fairly general conditions, this correlation factor is essentially the normalized integral over the source of the Fourier (frequency) transform of the spectral intensity function of the source, and that it may also be determined from simple interference experiments. Further, it is shown that in regions where geometrical optics is a valid approximation, the coherence factor itself then obeys a simple geometrical law of propagation. Several results on partially coherent fields, established previously by Van Cittert, Zernike, Hopkins, and Rogers, follow as special cases from these theorems. The results have a bearing on many optical problems and can also be applied in investigations concerned with other types of radiation. A.

535.41

10081. Interference in complex light with large path differences. J. J. Hunzinger. *Rev. Opt.*, **33**, 257–65 (*June*, 1954) *In French.*

Derivation of formulae for multiple-beam interference taking into account the complexity of spectral-radiation and line width. Fringe contrast is evaluated. The theory is applied to visibility effects for two wavelengths. The influence of a Gaussian distribution in the line source is discussed in detail. S. TOLANSKY

535.417

10082. Some applications of interferometry to precision measurement. C. F. Bruce. *Commonwealth Sci. Industr. Res. Org. Australia, Nat. Stand. Lab. Tech. Pap.*, *No.* 4, 16 *pp.* (1954).

A general account is given of some applications of optical interferometry to the measurement of length, angle, flatness, surface finish and vibration. Particular reference is made to multiple-beam interferometry and its application to surface structure and vibration problems. A.

535.417

10083. The geometrical optics of two-beam interferometers. H. Slevogt. *Optik*, **11**, *No.* 8, 366–79 (1954) *In German.*

A survey of the optimum geometrical conditions necessary in the use of the Michelson interferometer, the Twyman–Green interferometer and the Linnik interferometer, for the testing of optical components (including a Zeiss modification of the Linnik interferometry). Discussion of the sharpness and localization of the fringes. In general the middle points of the aperture and field stops must be imaged in the two auto-collimation points of those mirrors which form the generalized Michelson interferometer. S. TOLANSKY

535.417

10084. Remarks on the function of the multiple-beam interferometer used for the detection and the measurement of small differences in phase. G. Nomarski. *J. Phys. Radium*, **15**, S 26–S 30 (*June*, 1954) *In French.*

A theoretical analysis of the optimum conditions for best contrast when using the Fabry–Perot interferometer as an instrument for the detection of small phase differences. The paper discusses both application to large objects and to objects of very small lateral dimensions. A new expression is derived for the resultant amplitude for interference from the infinite series of diffracted waves. Attention is drawn to the modulating effect at infinity on the diffracted light. A new experimental set-up is proposed. S. TOLANSKY

535.417 : 548.5

On the observation of growth patterns of crystals by two beam interference methods. *See Abstr.* 10627

535.417–15 : 535.33.07

10085. The parallel plate interferometer for wave number calibration of infrared spectrophotometers. H. D. Polster. Letter in *J. Opt. Soc. Amer.*, **44**, 503 (*June*, 1954).

Attention is drawn to a small correction in the method described by Jaffe [Abstr. 2337 (1954)], which may, however, be smaller than the error in using a finite width of slit. G. F. LOTHIAN

535.42

10086. Diffraction at a circular aperture. W. Braunbek. *Z. Phys.*, **138**, *No.* 1, 80–8 (1954) *In German.*

Two approximate solutions of this problem have been given by the author, for the case where the radius of the aperture is large compared with the wavelength [Abstr. 6405–6 (1950)]. It is here shown that

the two approximations are in close agreement except in a small region of space near the centre of the aperture; the nature and cause of the disagreement in that region is examined. P. M. DAVIDSON

535.42

10087. Necessary corrections to Babinet's theorem. R. HOSEMANN AND D. JOERCHEL. *Z. Phys.*, **138**, *No.* 2, 209–21 (1954) *In German.*

Babinet's theorem requires correction because one cannot obtain diffraction patterns from two complementary screens of infinite extent. Mathematical formulae for the corrections are obtained and are illustrated by diffraction photographs. A. R. STOKES

535.42 : 534.321.9

10088. Diffraction of light by two ultrasonic beams. S. PARTHASARATHY AND H. SINGH. *Ann. Phys.* [*Paris*] **9**, 382–4 (*July–Aug.*, 1954) *In French.*

Two quartz crystals were excited simultaneously at different ultrasonic frequencies and the diffraction of a beam of light passed through them was examined. Particular study was made of the ratio of the intensities of the lines due to the sum and difference of the exciting frequencies, the line due to the difference being always the more intense. If the higher exciting frequency was maintained constant, this intensity ratio varied in the same sense as the lower frequency, as expected from theory. D. G. AVERY

535.42 : 535.315

10089. Some newly solved and some unsolved problems in optics. A. I. MAHAN. *J. Washington Acad. Sci.*, **44**, 165–94 (*June*, 1954).

Experience shows that most perfectly made roof prisms with two or three internal reflections exhibit a doubling of the diffraction pattern in a direction perpendicular to the roof edge, if the surfaces are uncoated. Silvering the surfaces largely removes the doubling. The author outlines the theory of this diffraction effect and shows that this agrees quantitatively with experiment. Further problems, yet unsolved, concerning the diffraction in other types of prism and with other boundary conditions are briefly discussed. The article is well illustrated with photographs of the diffraction patterns. R. W. FISH

535.42 : 535.822

10090. The Abbe theory of microscopic vision and the Gibbs phenomenon. G. L. ROGERS. *Amer. J. Phys.*, **22**, 384–9 (*Sept.*, 1954).

An elementary discussion suitable for teaching purposes. The effect of the phases in the back focal plane of the objective is briefly outlined. The consequence of limiting the aperture of the system in this plane is shown to be an image marred by diffraction. The relationship to Fourier's theorem having been indicated, the Gibbs phenomenon is next described. A standard formula for the finite sum of a Fourier series is taken and adapted to the case of imaging a suitable grating with a microscope objective limited by a slit aperture. If the grating slits are very narrow compared with the opaque region separating them, the image of each is shown to be married by a set of fringes, due to the Gibbs phenomenon, exactly equivalent to the diffraction fringes from the single slit in the microscope objective. A.

535.43.07

10091. Description of an apparatus for the study of the scattering of light. C. WIPPLER AND G. SCHEIBLING. *J. Chim. phys.*, **51**, 201–5 (*April*, 1954) *In French.*

Describes the optical principles of a photoelectric photometer for measuring scattered intensity as a function of angle. It includes a water-cooled Hg lamp, beams parallel to $1\frac{1}{2}°$, a cylindrical cell for specimens immersed in benzene and polarizing prisms. Test measurements give the molecular weights of polymer fractions, benzene being used as a standard. G. F. LOTHIAN

535.434

10092. Theoretical study of the scattering of light by sols of oriented rods. C. WIPPLER. *J. Chim. phys.*, **51**, 122–8 (*March*, 1954) *In French.*

The usual expression for the intensity scattered at angle θ by a rod of small relative refractive index is integrated for a large number of particles (1) oriented at random, (2) weakly oriented, using the 1st term of a Legendre polynomial to express the resulting particle distribution. The expressions obtained are discussed in relation to the orientation produced by a uniform electrostatic field and by fluid flow. The information that could be obtained by measurements on such systems is discussed with reference to the Kerr effect and to flow birefringence. G. F. LOTHIAN

535.434

10093. The first minimum in Mie scattering as a measure of the drop-size. M. M. PARANJPE AND D. T. PATEL. *J. Univ. Bombay*, **22**, 1–8 (*March*, 1954).

The angle of the first diffraction minimum is measured for drops of various sizes and refractive indices and the values compared with those calculated by the theories of Mie and of Ramchandran [*Proc. Indian Acad. Sci. A*, **17**, 171–86 (*June*, 1943)]. G. F. LOTHIAN

535.434.08

10094. The design of an optical system for the absolute measurement of turbidity. J. KREMEN AND J. J. SHAPIRO. Letter in *J. Opt. Soc. Amer.*, **44**, 500–1 (*June*, 1954).

With a uniform incident beam and suitable stops at 90°, the measurements needed are simple. Rayleigh's ratio for benzene at 436 mμ is found to be $46{\cdot}3\times10^{-6}$ cm^{-1}. G. F. LOTHIAN

535.435

10095. Lord Rayleigh's constant for standard liquids: definitions and principles of experimental methods. A. ROUSSET AND R. LOCHET. *J. Chim. phys.*, **51**, 13–17 (*Jan.*, 1954) *In French.*

Outlines the theory of scattering and reviews the various photographic and photoelectric measuring arrangements. It is concluded that the discrepancy between the two types of method cannot be attributed to neglect of a refractive index factor. G. F. LOTHIAN

535.435

10096. On the experimental study of macromolecular solutions by scattering of light. II. Description and standardization of a turbidity meter. S. GUINAND AND J. TONNELAT. *J. Chim. phys.*, **51**, 276–80 (*May*, 1954) *In French.*

See Abstr. 5372 (1949). The source used is a Hg vapour lamp, and the desired line is isolated by a

suitable filter. The light scattered by the solution falls on a photocell alternately with light from the source reduced in a controllable ratio. This ratio is adjusted till the photocurrent (presented on the screen of a cathode-ray oscillograph) is the same in each case, when the scattering factor is equal to the ratio in which the light is reduced. The apparatus does not therefore depend on linearity of cell response or on constancy of light source. The reduction of intensity of the comparison beam is effected by a neutral glass wedge and precautions are taken not to alter the state of polarization, so the apparatus is suitable for investigation of the polarization of the scattered light. A later paper will describe the results obtained and their significance.

N. CORCORAN

535.435 : 532.133

10097. Polyvinylacetate. A light scattering and viscosity study. A. R. SHULTZ. *J. Amer. Chem. Soc.*, **76,** 3422–30 (*July* 5, 1954).

Light scattering measurements on polyvinylacetate fractions in dilute solution confirm the prediction that the extent to which a linear polymer molecule is expanded beyond its random-flight dimensions is a function of its molecular weight. Thus the ratio of the mean-square radius of a linear polymer chain to its molecular weight, R^2/M, increases with increasing molecular weight for a polymer in a thermodynamically good solvent. The Flory–Fox limiting viscosity number theory is found to be valid for high molecular weight polyvinylacetate fractions in methyl ethyl ketone. The value $\Phi = 2{\cdot}2 \times 10^{21}$ is observed for the universal viscosity constant. The osmotic second virial coefficients, A_2, are empirically correlated with $\overline{M}_w$, $\overline{R}^2_w$ and $[\eta]$ in accord with the qualitative predictions of recent thermodynamic theories. A.

535.435 : 532.77

10098. Scattering of light in solutions, and determination of the optical anisotropy of molecules. M. F. VUKS, I. A. BOGDANOV AND V. I. ELFIMOV. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **17,** *No.* 5, 531–7 (1953) *In Russian.*

Measurements of the intensity of light scattered by pure aniline, phenol and nitrobenzene show deviations from the intensities predicted by theory for gases because of short-range oriented order in the liquids. At low concentrations in various solvents (carbon tetrachloride, ethyl alcohol, ether, acetone, heptane, cyclohexane) the anisotropic scattering produced by these substances is the same as would be produced in the gas phase at the same concentrations, but there are deviations at higher concentrations, indicating again interactions producing orientation, either between solute and solute, or solute and solvent, molecules. Raising the temperature counteracts this effect. The optical anisotropies calculated from the measurements are ($\times 10^{-48}$): nitrobenzene, 74; phenol, 39; aniline, 44. R. C. MURRAY

535.435 : 541.24 : 532.74

Investigation of polymer solutions by scattered light. *See Abstr.* 9976–7

535.51 : 538.566 : 530.145

Polarization and the Stokes parameters. *See Abstr.* 9924

535.514

10099. The polarization of light by means of aspherical ferromagnetic particles in an homogeneous magnetic field. I. Experimental investigations with a γ–Fe_2O_3 smoke. E. FICK. *Z. Phys.*, **138,** *No.* 2, 183–9 (1954) *In German.*

When a beam of light passes through a smoke of γ–Fe_2O_3 particles, suspended in air under the influence of a longitudinal magnetic field, it acquires a partial plane-polarization whose magnitude is a function of the field-strength, the optical extinction (itself a function also of the particle concentration) and the wavelength. For wavelengths between 4280 and 7260 Å, polarization values of $\sim 20\%$ are obtained with a field-strength of ~ 1 oersted. The change of extinction with wavelength is found to obey the λ^{-1} law. Based on the experimental results, a model is obtained to explain the observed polarization of starlight in its passage through interstellar matter. D. R. BARBER

535.514–15 : 535.323

10100. Polarization of [infrared] radiation and measurement of the index of selenium. P. BARCHEWITZ AND L. HENRY. *J. Phys. Radium*, **15,** 639–40 (*July–Aug.–Sept.*, 1954) *In French.*

Polarizers have been made (1) by reflection from 2 films of Se on NaCl; (2) by transmission through Se films on collodion—these are good to 40 μ, with, however, poor performance near $3{\cdot}5$ and $7{\cdot}8$ μ. The refractive index (n) of Se films on collodion was measured interferometrically; for $\lambda = 5$–15 μ, $n = 2{\cdot}4_2 - 2{\cdot}3_8$, increasing by $\sim 0{\cdot}04$ with age.

G. F. LOTHIAN

535.514.2

10101. Calculations concerning, and investigation of, a polarizer for the infrared. M. I. LISITSA AND A. A. SHISHLOVSKIĬ. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **17,** *No.* 5, 660–8 (1953) *In Russian.*

Formulae are worked out for the degree of polarization P of light passed by a pile of plates, making allowance for absorption in the plates, and interference in the thin layers of air between them. With proper dimensioning of the polarizer (thickness of the plates and of the air space between them) these two effects can increase the value of P, and i.r. light, incident at the Brewster angle on a pair of selenium plates, should come out $99{\cdot}5\%$ polarized: which is approximately confirmed by experiment. The formulae deduced are found to reproduce experimental results, e.g. for the variation of P with the angle of incidence, satisfactorily. A diagram of the arrangement for investigation of the polarization of i.r. light by a pile of selenium plates is shown. R. C. MURRAY

535.514.2

10102. On the polarised light remitted from transparent thin films. K. KUBO. *J. Sci. Res. Inst.* [*Tokyo*] **47,** 1–6 (*March*, 1953).

This theoretical paper gives expressions for the variation of the polarizing angle α and reflectivity as functions of the refractive index of a thin film. The spectral variation of these quantities is calculated for fixed values of n_1 (film) and n_0 (substrate). The degree of polarization is nearly independent of wavelength at $\alpha = 66°$. The expressions are applied to the transmitted beam when it passes through 4 filters:

the degree of polarization is found to be 99·74% and the transmissivity 50%. The advantages of this type of polarizer are discussed. R. A. WEALE

535.515

10103. Comments on the optics of birefringent crystals. M. P. GIVENS AND W. V. DISCHER. *Amer. J. Phys.*, **22**, 379–84 (*Sept.*, 1954).

Some of the optical properties of biaxial crystals are reviewed. Particular attention is given to the shapes of the wave surfaces and to the fact that true conical refraction cannot be observed. A.

535.52 : 535.343.2–15

10104. The near infrared absorption and the dispersion of ice and other crystals. J. W. ELLIS AND R. M. VANDERBERG. *J. Phys. Radium*, **15**, 612–14 (*July–Aug.–Sept.*, 1954) *In French.*

Optical axes of symmetry of monoclinic crystals are dependent on wavelength. A quantitative study has been made of rotation of optical axes of symmetry in gypsum between the visible and 2·7 μ. An anomaly is found at 1·9 μ (position of a band of water). For single crystals of ice an anomaly is found in the interference spectrum at 1·9 μ and 1·4 μ (no dispersion in the optical axes of symmetry) but no dichroism although there is a marked change in birefringence between two perpendicular orientations of the crystal. C. TURNER

535.55

10105. Multiple beam sharpening of photoelastic fringes. D. POST. Letter in *J. appl. Phys.*, **25**, 1060–1 (*Aug.*, 1954).

Fringes having good contrast are produced by placing mirrors of about 85% reflectance on each side of the photoelastic model. Intensity curves for sharpened and ordinary fringes are given for comparison and a sharpened pattern for a disk in diametrical compression is presented as a typical example of the method. The advantages of the process are discussed and it is suggested that the technique has great value in problems where low fringe orders or low fringe gradients are important. H. G. JERRARD

535.566.2 : 541.653

10106. Optical activity and molecular structure. M. V. VOL'KENSHTEĬN. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **17**, *No.* 5, 574–80 (1953) *In Russian.*

A discussion of the optical properties of secondary butyl alcohol, methyl- and ethyl-vinyl carbinols, in the light of the author's theory (1950). In contradiction of Kirkwood [*J. chem. Phys.*, **5**, 479–91 (*June*, 1937)], it is found that a second approximation for the gyration, or molecular constant of optical activity, must be taken into consideration to get reasonable agreement between theory and experiment. Theory also predicts a number of other known experimental facts, e.g. that unsaturated carbinols rotate the plane of polarized light more than the corresponding saturated substances. R. C. MURRAY

535.65

10107. Simple optical apparatus for determining the dominant hue and saturation of coloured lights and surfaces. P. SELÉNYI. *Acta phys. Hungar.*, **3**, *No.* 3–4, 205–12 (1954) *In German.*

A constant deviation spectrometer is modified by the addition of a second collimator which provides a beam of white light reflected into the telescope from one of the glass surfaces of the prism. Masks are placed over the prism surfaces so that a horizontally divided bipartite field is seen, the lower half being illuminated with a mixture of monochromatic and white lights, while the upper half is occupied, either by a white matt surface illuminated by the light to be measured or by the surface to be measured, illuminated by white light. A match is obtained by altering (*a*) the wavelength of the monochromatic light and (*b*) the intensities of the reflected white light and of the test light. The components in the matching mixture are then measured separately to obtain the saturation. J. W. T. WALSH

535.66 : 535.343

10108. Characteristic colour curves of powders. G. KORTUM. *J. Phys. Radium*, **15**, 630–2 (*July–Aug.–Sept.*, 1954) *In French.*

Spectra of xenon h.p. lamp-source reflected from finely-divided crystalline powders, e.g. $KMnO_4$ held at low temperature ($\sim 83°K$), have been obtained, and compared with the absorption spectra of the same materials. The principal maxima of extinction are found to coincide with the chief absorption band-heads. The quantity, $\log f(R) = \log \varepsilon + \log c +$ const., where $\log f(R)$ is a function of wavelength, ε is the molecular coeff. of extinction and c the molecular concentration per litre, is used to determine a "colour curve" characteristic of the crystalline solid examined. D. R. BARBER

535.7 : 612.84

Physiological optics. *See Abstr.* 10691–2

535.81

10109. The preparation and properties of pressed alkali halide disks with special reference to their use in spectroscopy. M. A. FORD AND G. R. WILKINSON. *J. sci. Instrum.*, **31**, 338–41 (*Sept.*, 1954).

A vacuum mould and press are described for the pressing of alkali halide powders to form transparent disks, which have optical quantities similar to crystals of the same thickness. The nature of the process has been investigated with special reference to the production of good quality disks for use in spectroscopy. A.

535.81

10110. Investigations into the apodization of optical images. B. DOSSIER. *Rev. Opt.*, **33**, 57–111 (*Feb.–March*); 147–78 (*April*); 267–97 (*June*, 1954) *In French.* Summary (800 words) *in English.*

These papers form a general theoretical study of the conditions for effective apodization of an optical system. It is shown that phase changes alone or amplitude changes due to interference at the pupil are both impracticable. Absorption screens with transmissions of 0·3 to 0·6 can, however, be made effective. Screens of circular and rectangular form are investigated to determine the optimum conditions, and it is found that the rectangular screen gives greater transmission. The theoretical results are confirmed by photographic photometry for the case of the rectangular screen. 27 references are given. R. W. FISH

535.822

10111. Photometry of the microscope with special reference to projection. F. E. J. Ockenden. *J. sci. Instrum.*, **31**, 309–13 (*Sept.*, 1954).

The transmission losses occurring in microscope optical systems are discussed and their effect on the brightness of both visual field and projected images is estimated. When the conditions requisite for maximum efficiency are complied with a simple formula enables the highest possible screen or visual field illumination to be readily calculated from the known constants of the illuminant and the optical components. It is shown that the production of large, well-illuminated, projected images by means of a microscope is subject to limitations for which the only solution is the provision of illuminants having a higher intrinsic brilliance than any at present available. A limitation on screen brightness may in some instances have to be imposed by the need to limit the energy in transversing the specimen. A.

535.822.7

10112. The development of binocular microscopes. C. H. Claussen. *Z. wiss. Mikr.*, **61**, 406–13 (*April*, 1954) *In German.*

535.89

10113. Investigations concerning light sources for spectrum analysis. V. High voltage spectrographic spark source with electronic control. A. Bardócz. *Acta tech. Hungar.*, **8**, *No.* 1–2, 99–106 (1954).

For Pt II, see Abstr. 5518 (1954). For the control of high voltage spectrographic spark sources a circuit consisting of a fixed controlling spark gap and a thyratron tube is employed. The controlled energy does not pass through the thyratron tube, this being only the initiating element of the discharge. The grid of the thyratron tube is controlled by a pulse generator. The charging voltage of the condenser is uniformly distributed between the controlling and the analytical gap. On starting the current flow by a controlling pulse to the thyratron tube, first the controlling spark gap and then the analytical gap sparks over. Following this the whole condenser energy passes through the two spark gaps. Some curves characteristic of the operation of the system are given. A.

535.89 : 535.375.5

10114. Low pressure mercury lamp, and its use for the investigation of light scattering. M. L. Sosinskiĭ. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **17**, *No.* 5, 621–3 (1953) *In Russian.*

A drawing (undimensioned) of the lamp is given, and some numerical characteristics: current passed, 5–15 A; light flux per unit length for the 4358 Å line, 5–43; half-width of the 4358 Å line, 0·014–0·021 Å. The new lamp gives a more detailed Raman spectrum from, e.g. carbon tetrachloride, than the present standard Russian lamp PRK–2. R. C. Murray

535.89 : 778.37

10115. A method of generating light flashes at a high repetition frequency. H. Luy and R. Schade. *Z. angew. Phys.*, **6**, 253–7 (*June*, 1954) *In German.*

Describes a specially developed spark gap for providing the intense light flashes which are used in high-speed photography. The circuit arrangement is briefly treated, and light–time oscillograms (duration a few μsecs) are shown for the spark source of illumination. Two mechanical applications are shown, with repetition rates of 2000 and 4000 frames/sec.

J. D. Craggs

HEAT 536

536.2.01

10116. Thermal conductivity of crystals and liquids. S. Mizushima. *J. Phys. Soc. Japan*, **9**, 546–52 (*July–Aug.*, 1954).

Thermal conductivity of crystals without defects is calculated using the approximation that the mutual collisions of phonons of the normal type occur far more frequently than the umklapp collisions. The conductivity K for crystals at temperatures not too far below the characteristic temperature, and above, is expressed as $K \sim 0{\cdot}1\{[qa(U/V)]/QT\}$, where q is the sound velocity, a the lattice constant, U/V the cohesive energy per unit volume, T the absolute temperature and Q is a number of the order of unity introduced to take into account the difference of the crystal structure. This formula fits fairly well to observed values for ionic crystals having NaCl-type lattice and furthermore applies equally to the conductivity of liquids. In the latter case it is shown that the above formula is approximately identical with the well-known formula proposed by Bridgman. A.

536.2.01

10117. Role of low-energy phonons in thermal conduction. C. Herring. *Phys. Rev.*, **95**, 954–65 (*Aug.* 15, 1954).

Phonon-phonon collisions in which one of the phonons is of very low frequency have recently become important for the understanding of the thermoelectric powers of semiconductors at low temperatures. Such collisions have also an interest from the standpoint of thermal conduction, since previous theories, which neglect elastic anisotropy, have predicted a very large thermal conductivity for a hypothetical perfect crystal of very large size. It is shown here that elastic anisotropy has a drastic effect on the collision probabilities of modes of very low frequency. A relaxation time τ can be defined, for any mode, which at temperatures T well below the Debye temperature and for wave vectors q as well within the acoustic range obeys $\tau(\lambda\mathbf{q}, \lambda T) = \lambda^{-5}\tau(\mathbf{q}, T)$. As $\mathbf{q} \to 0$, $\tau^{-1} \sim \Lambda_a q^a$, where normally, for modes of the longitudinal branch, $a = 2$ for the crystal classes of highest symmetry, 3 and perhaps sometimes 4 for those of lower symmetry. For traverse modes a is normally 1. These asymptotic laws, whose range of validity can be roughly estimated, enable us to calculate the contribution of the low-frequency longitudinal modes to the conductivity. This contribution, though small, may be perceptible at temperatures far above the range where Casimir's formula applies. A.

536.2.083

10118. Methods for studying the thermal resistances of sprayed and electro-deposited metal coatings. R. W. Powell and M. J. Hickman. *Brit. J. appl. Phys.*, **5**, 312–15 (*Sept.*, 1954).

Two methods are described for investigating the

additional thermal resistance introduced when the plane end of a metal bar is coated with sprayed steel or an electro-deposited metal. One is applicable to underground surfaces and involves the use of a thermopile for surface temperature measurement. The other can only be used on flat surfaces and is a modification of the divided bar method. When applied to coatings a few millimetres thick, this method enables determinations to be made both of the thermal resistance of the deposited metal and of its bond to the underlying metal. The thermal conductivity of sprayed steel was about one-seventh of that of a similar steel in the normal form. A.

536.21

10119. Thermal diffusivity of metals at high temperatures. D. Rosenthal and N. E. Friedmann. Letter in *J. appl. Phys.*, **25**, 1059–60 (*Aug.*, 1954).

A direct method alternative to that of Ångström (in which a periodically varying temperature is applied to one end of a long bar), is based on the establishment of a quasi-stationary state in a long bar swept by a moving heat source. Advantages are: (i) source temperature need not be known; (ii) radiation and convection losses need not be determined; (iii) values can be obtained in a temperature range so narrow that it becomes practically a value at a fixed temperature. Results compare well with those from other sources and reproducibility is 2% or better when the thermal diffusivity exceeds 0·2 cm²/sec. Direct determinations of diffusivity are often expedient, but should not be used if values can be calculated from existing thermal data. E. H. DOCK

536.21 : 548

10120. The thermal conductivity of gallium single crystals at low temperatures. H. M. Rosenberg. Letter in *Phil. Mag.*, **45**, 767 (*July*, 1954).

There is broad agreement between the anisotropy in both thermal and electrical resistance down to the temperature range 2–40°K. C. A. HOGARTH

536.21 : 548.7

The lattice thermal conductivity of silver-palladium alloys at low temperatures. *See Abstr.* 10631

536.24

10121. Heat transfer in laminar flow between parallel plates. J. Schenk and H. L. Beckers. *Appl. sci. Res. A*, **4**, *No.* 5–6, 405–13 (1954).

The heat transfer from a liquid passing in fully established Poiseuille flow between flat parallel plates of finite thermal transmissivity is treated for an arbitrary transverse temperature distribution in the liquid at the inlet. The temperature at any point of the liquid can be represented by a series of eigenfunctions. The even eigenfunctions of this problem have been calculated in earlier work; in this paper the first three odd eigenfunctions are added. The results also bear on the case where the temperature of the environment at one side differs from that at the other side of the conduit. For this case the transmission coefficient is calculated. The influence of the odd terms on the thermal entry length is also discussed. A.

536.25

10122. The influence of melting and anomalous expansion on the thermal convection in laminar boundary layers. H. J. Merk. *Appl. sci. Res. A*, **4**, *No.* 5–6, 435–52 (1954).

The problem of thermal convection occurring when a solid melts in the stationary liquid phase of the same substance is complicated by the melting process, which introduces a moving boundary. If the melting solid is ice, a further complication arises from the anomalous thermal expansion of water at about 4°C, which causes a phenomenon called convective inversion. The boundary layer theory is here applied to calculate the influence of these two effects. The calculations are performed with a refinement of the Squire–Eckert approximation for large values of the Prandtl number. In a paper being published later Dumoré will compare the theoretical results of this paper with his experiments on spheres of ice in water. A.

536.25

10123. Discrete transitions in turbulent convection. W. V. R. Malkus. *Proc. Roy. Soc. A*, **225**, 185–95 (*Aug.* 31, 1954).

The convection in a fluid between horizontal conducting surfaces is a very simple example of thermal turbulence, for the mean heat transport is independent of position while the distance between these surfaces is the only geometric parameter. This paper describes measurements of the heat transport and mean velocity in such convection up to Rayleigh numbers of 10^{10}. Six discrete transitions in the slope of the heat-transport curve were observed between Rayleigh numbers of 1700 and 1 000 000. Although the thermal gradients vary by an order of magnitude from a boundary to the mid-regions of the fluid, these transitions appear to agree with those deduced on an assumption of a constant thermal gradient. Various visual observations of the fluctuating velocity field are also reported. Additional vertical barriers in the fluid markedly influence the horizontal flow but have negligible effect on the heat transport. This apparent lack of uniqueness of the flow patterns associated with a given heat transport suggests a new approach to turbulent phenomena discussed in a following theoretical paper. [See next abstract.] A.

536.25

10124. The heat transport and spectrum of thermal turbulence. W. V. R. Malkus. *Proc. Roy. Soc. A*, **225**, 196–217 (*Aug.* 31, 1954).

A theoretical investigation is made of various properties of the steady-state inhomogeneous turbulent convection of heat in a fluid between horizontal conducting surfaces. An upper limit to the heat transport is found subject to the constraint that some minimum eddy size exists which is effective in this transport. The spectrum of convecting motions, the mean thermal gradients at each point and the eddy conductivity are then determined in terms of the minimum eddy size. The relation between the boundary conditions and eddy size is studied by an extension of the work of Pellew and Southwell using the mean thermal gradients deduced when n_0 modes of motion are present to establish the Rayleigh number at which the $(n_0 + 1)$th mode first becomes unstable. In a final section the spectra and mean-square values of the fluctuating velocity and temperature fields are estimated from the Boussinesq

form of the hydrodynamic equations. The previously reported experimental heat transports are within 10% of those predicted. The discrete transitions are within the error limits of the observations. However, further data must be gathered to justify the use of minimum eddy size as a defining parameter in situations of geophysical scale. A.

536.253

10125. Experimental study of some phenomena of natural convection from wires. C. Bory. *Ann. Phys.* [*Paris*] **9**, 141–57 (*March–April*, 1954) *In French.*

The loss of heat by natural convection, first from a hot Pt wire 340·6 mm long and 77·1 μ dia. stretched horizontally along the axis of a cylindrical enclosure containing air at temperature t_0, and second from two similar wires 420 mm long and from 1–14 mm apart placed symmetrically with respect to the axis is studied as a function of the temperature t_1 of the wires and of t_0. The experimental arrangement and method of measurement are described, and the results shown graphically. The temperatures t_1 were obtained from the electrical resistance of the wires, and t_0 was measured by Pt resistance thermometers suitably placed in the enclosure. For the single wire the linear coefficient of convection $h = W_1/l\theta$ where W_1 is the power dissipated by convection, l the wire length and $\theta = t_1 - t_0$, was measured for five values of θ between 10 and 400° and for t_0 between 18 and 100°. The results show that for low heatings h has two clearly distinct values for a given θ and t_0, and for constant heating the curve of h as a function of t_0 goes through a minimum. For the two wires $\theta = 10$, 50, 140 and 400° were studied and for distances apart of 1, 2, 4, 8 and 14 mm. The dissipation of heat increased as the two wires were brought closer together, being particularly marked for the low heatings. S. WEINTROUB

536.413 : 548.736.3

10126. Lattice expansion of KCl single crystals between 20°C and 600°C. R. E. Glover III. *Z. Phys.*, **138**, *No.* 2, 222–36 (1954) *In German.*

Precision measurements on crystals of KCl, both pure and containing Ca impurity, were done by X-rays and macroscopically. In all cases both measurements agreed within the experimental accuracy, and any discrepancy in density at 600°C must be less than 1·5%. W. M. LOMER

536.421.1

10127. An experimental determination of the melting curves of argon and nitrogen into the 10 000 atm region. D. W. Robinson. *Proc. Roy. Soc. A*, **225**, 393–405 (*Sept.* 14, 1954).

A new apparatus for measuring melting curves at low temperatures and very high pressures is described. It is essentially a combined cryostat and high-pressure intensifier connected by a single junction at room temperature. The pressure is produced in a number of stages culminating in a single intensification stroke on to a small volume of gas maintained at low temperatures in a long steel tube. Solidification and melting are detected in this tube by means of a small steel pellet, which may be moved by an external magnetic field when the substance is fluid. Experiments have been carried out on argon and nitrogen. The solid-fluid equilibrium line has been extended to 8250 atm at 234°K for argon, and to 9100 atm at 180°K for nitrogen. A.

536.422

10128. Phenomenology of the [gaseous] film which is formed by sublimation of solid compressed carbon dioxide. A. Sellerio and G. B. Collura. *Nuovo Cimento Suppl.*, **11**, *No.* 1, 17–42 (1954) *In Italian.*

First, the film of equilibrium thickness h formed between a metal plate at a controlled temperature t_1 and a block of solid CO_2 (dry ice) at temperature t_2 on which the plate is placed is discussed theoretically, and it is shown that the thermal problem is dependent on the aerodynamical problem of the motion of the gas between the surfaces enclosing the film. The aerodynamical problem is treated mathematically and the solutions obtained are used to derive relationships for the pressure variation radially in the film and for the coefficient of heat transfer K between the plate and block. For constant temperature difference $(t_1 - t_2)$, K is proportional to $G^{\frac{1}{4}}$ to a first approximation where G is the force exerted downwards by the plate. An apparatus is described for the determination of the radial pressure variation and of K. It is shown that when the plate is allowed to oscillate up and down acoustical vibrations are produced of frequency corresponding to a simple pendulum of length $\frac{1}{4}h$. In the second half of the paper the composition of, and movement within, the film formed when the surface of the block of dry ice is exposed to free air, either still or in motion, are discussed. The structure and movement of the film was studied by illumination with diffused light and details are given of the results obtained. S. WEINTROUB

536.422

10129. A study of the evaporation products of alkaline-earth oxides. I. Pelchowitch. *Philips Res. Rep.*, **9**, 42–79 (*Feb.*, 1954).

A mass spectrometer [Abstr. 10266 (1954)] is used to study the evaporation phenomena in systems where the alkaline-earth oxides are coated on electrically heated metal ribbons. BaO evaporates mainly in the form of the oxide when it is coated on Pt and Ni or coated in admixture with SrO and CaO on Pt. When the BaO/Pt system is brought to high temperatures, an ion current of Ba_2O_2 can be measured. In the SrO/Pt and CaO/Pt systems the main evaporation product is the free element accompanied by the oxide and the singly ionized metal ions. The main evaporation product in the BaO/Ta system is free Ba accompanied by the expected amount of the oxide and by singly ionized Ba ions which can be measured at higher temperatures. When the experimental results of ion-current dependence on temperature are fitted to an equation of the form $\log I = -A/T + B$, I being the ion current at a certain M/e value measured at the sample temperature T°K, unexpected results are found. The evaporation-rate curve drawn using $\log_{10} I$ and $10^4/T$ as co-ordinates is not in all cases a single straight line. The evaporation curve of BaO from all BaO systems coated on Pt can be best described in the measured temperature range as two lines differing in slope joining at the temperature point $T = 1250$°K. A critical behaviour in the evaporation-rate curve of free Ba evaporating from the system BaO/Ta seems to

occur when this temperature point is reached. A different behaviour of the evaporation-rate curve of BaO is observed in the BaO/Ni system, the transition point at 1250°K disappearing. It is then proved, however, that the Ni base metal evaporates through the BaO porous layer and that the evaporation-rate curve of Ni behaves critically in the neighbourhood of $T = 1250$°K. A transition point in the evaporation-rate curve of free Sr is found in the system SrO/Pt. It is reversible with temperature and the temperature value is $T = 1600$°K. In view of the unexpected results found in the evaporation-rate curves, resistance measurements of the systems are made using oxide layers pressed between metal electrodes. All the above-mentioned transition points appear clearly in the resistance behaviour with temperature. The difference between Pt and Ni as base metals is also indicated. Finally the experimental results are compared critically with data from the literature. A.

536.423 : 533.7

10130. Statistical theory of phase transition. I. General theory for lattice gas. I. SHIMOSE. *J. Phys. Soc. Japan*, **9**, 451–6 (*July–Aug.*, 1954).

The statistical properties of phase transitions from the point of view of molecular clusters are interpreted. Results for a lattice gas are expected to be qualitatively correct, though these are approximate from the quantitative point of view. The partition function, the pressure and the density of a lattice gas are calculated in their general forms. Particularly, the discontinuity of the derivative of the isotherm in $P - v$ diagram is derived from the calculation of the partition function. A.

536.423 : 533.7

10131. Statistical theory of phase transition. II. Numerical calculation for lattice gas. I. SHIMOSE. *J. Phys. Soc. Japan*, **9**, 457–9 (*July–Aug.*, 1954).

The pressure and the densities (vapour and liquid) at the transition point of a lattice gas (square lattice type) are calculated for some ranges of temperature (or some values of x), using the theory derived in Pt I. Values agree well with the exact values obtained by the matrix method. For small values of x (for example, $x = 0{\cdot}3$ or $T/T_c = 0{\cdot}7321$), the values of partition function are given as a function of q. The isotherm obtained from these values has a portion parallel to v-axis (corresponding to $P =$ constant) and at both ends of this portion the derivatives of the isotherm are discontinuous. Furthermore, the system in question is shown qualitatively to have the above properties also for larger values of $x (x < x_c)$. A.

536.423 : 537.57

10132. Influence of ions on the nucleation processes in liquids. I. Liquids in stable thermodynamical equilibrium. G. MARTELLI. *Nuovo Cimento*, **12**, 250–9 (*Aug.*, 1954).

An attempt is made to study the nucleation of vapour bubbles in liquids, when the contribution of the ions is also taken into account. Some results show substantial differences from those obtained on the basis of the usual theories. The particular case of liquids in stable equilibrium is discussed in some detail. A.

536.423.1

10133. On the conduction of heat into a growing vapor bubble. H. K. FORSTER. Letter in *J. appl. Phys.*, **25**, 1067–8 (*Aug.*, 1954).

A theoretical paper which gives the derivation of the expression used [Abstr. 5540 (1954)] for the temperature of the moving wall of a bubble growing in a superheated liquid. L. G. CARPENTER

536.423.15

10134. On a universally valid empirical approximate formula for the saturation vapour pressure. E. WALDSCHMIDT. *Z. angew. Phys.*, **6**, 313–18 (*July*, 1954) *In German.*

The vapour pressure is found to be expressible in terms of the temperature, the normal boiling point, and a constant which can be derived from the entropy of boiling. The formula is compared with experiment for 15 elements and 36 inorganic and organic compounds. L. G. CARPENTER

536.424.1

10135. Contribution to the study of the transformations of the oxides of vanadium. J. JAFFRAY AND A. DUMAS. *J. Rech. Cent. Nat. Rech. Sci., No.* 27, 360–6 (1954) *In French.*

V_2O_3 shows a polymorphic change at −110°C and a transition at 250°C which involves anomalies in specific heat, dilatation and electrical and magnetic properties. Another change occurs at 100°C but has not been studied. V_2O_4 shows anomalies at −150°C and a polymorphic change at 70°C. The changes were followed by X-rays, dilatometry and electrical measurements, and thermal analysis. W. M. LOMER

536.461

10136. The effect of drop size on flame propagation in liquid aerosols. J. H. BURGOYNE AND L. COHEN. *Proc. Roy. Soc. A*, **225**, 375–92 (*Sept.* 14, 1954).

A method has been developed whereby suspensions of controlled uniform drop size can be prepared from pure liquids. Using tetralin as the fuel, it has thus been possible, within limits, to study the effect of the drop size on the combustion properties of a liquid-in-air suspension. Through a study of limits of inflammability, nitrogen dilution limits and burning velocities, it has been shown that the mechanism of flame propagation is completely transformed within the drop-size range 7 to 55 μ. Below 10 μ the suspension behaves like a vapour, but above 40 μ the drops burn individually, in their own air envelope, and one burning drop ignites adjacent ones, thus spreading combustion. At intermediate sizes, behaviour is transitional. A practical consequence of this transformation is that the lower concentration limit of inflammability is reduced and the rate of burning increased for the larger drops. A.

536.48 : 538.222

Thermal properties of Cr methylamine alum below 1° K. *See Abstr.* 10335

536.48 : 539.152.2

Magnetic resonance of oriented nuclei. *See Abstr.* 10427

536.48

10137. On the theory of liquid He^3–He^4 mixtures. L. GOLDSTEIN. *Phys. Rev.*, **95**, 869–84 (*Aug.* 15, 1954).

An asymptotic theory of liquid He^3–He^4 mixtures

is presented, in which the component fluids are described, approximately, in terms of ideal symmetric and antisymmetric fluids. The theory yields results in at least semiqualitative agreement with the data if the antisymmetric fluid is taken to be of negligible degeneracy. The computed isothermal mixing energies and entropies are good approximations to the preliminary data on these quantities obtained in this Laboratory. The present model exhibits complete miscibility at all temperatures together with a vanishing total and mixing entropies, in all possible mixtures, at the approach of the absolute zero. It is shown that the mixtures undergo third-order phase changes along their transition line, where their constant-volume and constant-pressure heat capacities have sharp peaks, with λ-point type discontinuities of their temperature derivatives. On mixing the ideal symmetric fluid with an ideal antisymmetric or classical fluid the original first-order phase change of the former, as a result of its momentum space condensation, has thus been modified. The theory requires that, below the phase transition line of the mixtures, the momentum space condensed and uncondensed atom groupings be such that the latter group should include all the He^3 atoms. As a result, the observed modifications in the velocities of propagation of second sound waves from their values in pure liquid He II are automatically accounted for. The theory also accounts, in this way, for the large observed changes in the second sound wave field tensions in mixtures from their values in pure liquid He^4. It also explains the decrease observed in this Laboratory of the He^4 film-flow rates in mixtures as compared with the rates in liquid He^4, if this rate is taken to be proportional to the fraction of condensed atoms. The paper ends with a brief discussion of the transition surface of mixtures in the pressure-temperature-He^3 mole fraction affine space. Here the likelihood of a further depression of mixture phase transformation temperatures by application of external pressure is pointed out. Finally, the apparent analogies between the perturbations of the phase transformation of liquid He^4 by external pressure and by mixing it with liquid He^3 are briefly reviewed. A.

536.48

10138. Lambda transition of liquid helium. D. TER HAAR. *Phys. Rev.*, **95**, 895–7 (*Aug.* 15, 1954).

An approximate partition function for a system of interacting Bose–Einstein particles is derived, which is nearly the same as the one derived by Feynman, by neglecting the non-commutability of the potential and kinetic energy operators. Reasons are given for believing that the approximations introduced in deriving the partition function rather than those introduced in the further development of the partition function are responsible for the difference between the observed and the predicted order of the transition. A.

536.483

10139. A new type of helium liquefier. H. M. LONG AND F. E. SIMON. *Appl. sci. Res. A*, **4**, *No.* 4, 237–42 (1954).

Describe plant producing liquid helium at a rate of 600 cm^3/hr consuming 1400 cm^3 liquid air per hour for precooling. Cold is produced in an expansion engine consisting of brass bellows where part of the precooled gas is expanded from 5·5 to 1·3 atm. Remaining gas of 20 atm is cooled by heat transfer to 15°K and liquefied by porous plug expansion. Life time of bellows is not smaller than 10^4 cycles. Use of hydrogen is avoided. Plant has been working for 7 months. R. EISENSCHITZ

536.483

10140. Two types of regulators and the precision control of helium bath temperature. H. S. SOMMERS, JR. *Rev. sci. Instrum.*, **25**, 793–8 (*Aug.*, 1954).

A pneumatic and an electronic regulator for helium bath temperature are described. The pneumatic regulator, an automatic pressure regulating valve with large throughput, gives a simple controller suitable for regulation to a millidegree for temperatures above 1·4°K. The electronic control uses a carbon resistor for the thermometer and a heater inside the bath for the control element. Its regulation is an order of magnitude better, and it is usable at all achievable temperatures. Its theoretical analysis, circuit diagram, construction and operating details, and performance are described. Included are some general remarks and results concerning temperature regulation in He I and at the λ-point. A.

536.532 : 578.087.86

Improved needle-thermocouple. *See Abstr.* 10689

536.587 : 621.316.7

10141. A thermostat with control temperature independent of ambient temperature. A. M. THOMPSON AND R. W. ARCHER. *Proc. Instn Elect. Engrs II*, **101**, 450–2 (*Aug.*, 1954).

A circuit is described for the precise temperature control of the oven of a quartz-crystal frequency standard. A temperature-sensitive bridge of copper and manganin resistors is used as the amplitude control of an oscillator, power from the oscillator heating the oven. It is shown that the temperature of an isothermal oven is maintained independent of ambient temperature and depends only on the gain of the maintaining amplifier. An application of the thermostat is described in which the oven temperature of about 50°C is maintained within ± 1 millideg. A.

536.627 : 535.23.08

10142. Absolute water flow calorimeter for the measurement of intense beams of radiant energy. A. B. WILLOUGHBY. *Rev. sci. Instrum.*, **25**, 667–70 (*July*, 1954).

A null instrument for the measurement of intense beams of radiant energy (from about 5 to 300 cal. cm^{-2} sec^{-1}) is described. The instrument utilizes two identical hollow blackbody receivers whose walls are provided with coils carrying a stream of cooling water. The inflowing water divides equally between each chamber. The temperature difference between the two outflows is determined by a differential thermopile. One of the chambers is exposed to the radiant energy beam, while the other chamber is heated electrically until a null is obtained on a galvanometer connected to the differential thermopile. It is shown that measurements of the electrical power dissipated in the chambers under null conditions and a measurement of the aperture areas of the chambers is sufficient to give the radiant flux density. A.

536.631

10143. Temperature variation of the mean Debye temperature of Cu_3Au, 20°C to 450°C. S. L. QUIMBY. *Phys. Rev.*, **95**, 916 (*Aug.* 15, 1954).

The temperature variation of the mean Debye temperature of crystalline Cu_3Au at equilibrium order is computed from the values of the elastic constants at equilibrium order obtained by Siegel. The Debye temperature decreases from the value 272°K at 20°C to the value 234°K at 450°C, with a discontinuous drop from 249°K to 239°K at the critical temperature for disordering, 387°C. A.

536.631

10144. On the specific heat anomalies of cobalt oxide CoO and the solid solutions CoO–NiO and CoO–CuO. G. ASSAYAG AND H. BIZETTE. *C.R. Acad. Sci.* [*Paris*] **239**, 238–40 (*July* 19, 1954) *In French.*

Specific heats were measured by Andrews (1926) method using benzoic acid and aluminium as comparison standards. A sharp anomaly for CoO is found at 289·7°K. This is close to the temperatures of susceptibility maximum, expansion coefficient anomaly and change of Young's modulus. The temperatures of the anomalies in solid solutions of CoO and NiO vary linearly with molecular composition. For 91·7 CoO–8·3 CuO the anomaly is at 284·9°C. This is the same as obtained by linear interpolation from the pure components. F. E. HOARE

536.631 : 548.7

10145. Lattice vibration specific heat of graphite. T. NAGAMIYA AND K. KOMATSU. Letter in *J. chem. Phys.*, **22**, 1457–8 (*Aug.*, 1954).

Criticizes aspects of the calculations of Krumhansl and Brooks [Abstr. 417 (1954)] and Rosenstock [Abstr. 1857 (1954)], and gives preliminary results of a different calculation. The temperature of transition from the T^3 to the T^2 law is given approximately by the relation $kT = nh/4\pi\rho\kappa$, where n is the rigidity modulus corresponding to interplanar slip, ρ the density, $\rho\kappa^2/c$ the shear modulus of one plane and c the interplanar distance. E. P. WOHLFARTH

536.654

10146. Direct determination of the heat of sublimation of carbon. W. A. CHUPKA AND M. G. INGHRAM. Letter in *J. chem. Phys.*, **22**, 1472 (*Aug.*, 1954).

Reports experiments using a tantalum Knudsen cell with graphite lining and mounted in a mass spectrometer to provide analysis of the effusing vapour. The latent heat was found to be 170·4 kcal. mol^{-1}. E. P. WOHLFARTH

536.656

10147. The activation energy for the solid state reaction γ-$Fe_2O_3 \rightarrow \alpha$-$Fe_2O_3$. F. E. DEBOER AND P. W. SELWOOD. *J. Amer. Chem. Soc.*, **76**, 3365–7 (*July* 5, 1954).

Thermomagnetic measurements have been made on γ-ferric oxide prepared in several ways and with the addition of alumina, lanthana and gallia. The experimental data have been used to calculate the activation energy for the transformation γ-$Fe_2O_3 \rightarrow \alpha$-$Fe_2O_3$. The activation energy for this reaction depends on previous heat treatment. It is raised by the presence of alumina, lowered by lanthana, and unaffected by gallia. A.

536.666 : 539.11

10148. The calculation of heats of formation of binary alloys. J. H. O. VARLEY. *Phil. Mag.*, **45**, 887–916 (*Sept.*, 1954).

A theoretical treatment for calculating the heats of formation of binary alloys for any composition is put forward. The model is based upon the assumption that the free electrons in a binary alloy exist in two sets of energy levels associated with the potential fields of the ions of the two elements in the alloy. This assumption is a natural consequence of neglecting the changes in the Wigner–Seitz boundary conditions, imposed upon the electrons in the pure elements, when the atoms are randomly mixed in an alloy. Fair agreement between calculated and experimental heats of formation is obtained for many systems, in which the two elements composing a given system are not too far removed from one another in the periodic classification of the elements. Some consequences of the theory are discussed, in particular the magnetic behaviour of alloys can be qualitatively explained, the relative valency effect is also a natural prediction of the theory and the observed dependence of Fermi band width on composition in some binary alloys is accounted for. A.

THERMODYNAMICS 536.7/.8

536.7

10149. Thermodynamic functions for borine carbonyl. H. J. GALBRAITH. Letter in *J. chem. Phys.*, **22**, 1461–2 (*Aug.*, 1954).

C_p°, $(H^\circ - E_0^\circ)/T$, $(-F^\circ - E_0^\circ)/T$ and S° from 100–600°K at 20 deg. intervals are calculated from the vibration frequencies and the geometrical structure of BH_3CO. D. H. WHIFFEN

536.75

10150. Maxwell's demon must remain incommunicado. M. J. E. GOLAY. Letter in *J. appl. Phys.*, **25**, 1062 (*Aug.*, 1954).

Following up Brillouin's discussion of the Demon in the light of information theory [Abstr. 3500 (1951)], the author points out that even if the molecule sensing system of the Demon were to operate without an increase in entropy, the process of communicating the necessary information to it would require too great an entropy increase. T. P. BRODY

ELECTROSTATICS . DIELECTRICS 537.2

537.21

10151. Some elementary concepts in electrostatics. D. G. FROOD. *Amer. J. Phys.*, **22**, 369–73 (*Sept.*, 1954).

Points out that Gauss's law is insufficient, except in special cases, to solve simple problems in electrostatics. In any system of dielectrics and charged conductors an additional condition, viz., that the total free energy is at a minimum, is necessary to determine the equilibrium values of the fields. As

will be seen, this requirement amounts to the statement that in electrostatics the potential across any conductor is continuous. For the sake of generality, the permittivities of the dielectric media are considered to be inhomogeneous, temperature dependent and also field-strength dependent. The last property being included in case some (or all) of the dielectrics have the perovskite structure as, for example, in the titanates, tantalates, niobates, zirconates, etc. Consideration is given to interesting special cases of the generalized results. A.

537.212 : 538.12 : 621.3.013

10152. Calculation of some magnetic and electric fields with cylindrical symmetry. Y. Axner. *Appl. sci. Res. B*, **4**, *No.* 1–2, 124–36 (1954).

It is assumed that the magnetic and electric fields have cylindrical symmetry and at the same time mirror symmetry with respect to a median plane. The field strength in the median plane is given. The problem is to calculate the field at an arbitrary point in space, the equipotential surfaces, and the form of the pole-pieces of magnets. Solutions are given in the form of power expansions. Analytical solutions are given when the field strength in the median plane as a function of the radius is a polynomial. A.

537.212.08 : 621.317.729

10153. Electric field meters. R. Gunn. *Rev. sci. Instrum.*, **25**, 432–7 (*May*, 1954).

The fundamental principles of electric field measurement by the use of inductors and vacuum tube amplifiers are reviewed. An electric field meter is described that employs a rotating inductor and a synchronous a.c. generator to provide a sign-responsive meter reading proportional to the electric field. The synchronized circuits eliminate moving contact rectifiers and promote calibration stability. A simplified field meter using rectified inductor currents to operate a high-impedance push-pull bridge circuit is also described. Design features are incorporated in both instruments that permit them to operate continuously under unusually severe storm conditions. A.

537.212.08 : 621.317.729

10154. An electric field meter with extended frequency range. L. G. Smith. *Rev. sci. Instrum.*, **25**, 510–13 (*May*, 1954).

The frequency range of a field meter of the field mill type has been extended by applying a system of balanced modulation. This is achieved by incorporating two complementary sets of stators. The amplified signals from the stators are detected in a clamping circuit. In the instrument which is described, the frequency range extends to 22 kc/s although the modulation frequency is 120 c/s. The method by which the frequency range has been extended can be adapted to other instruments employing mechanical modulation. A.

537.224 : 621.3.011.4 : 621.339.4

10155. The capacity and field of a split cylindrical condenser, using the method of inversion. H. J. Peake and N. Davy. *Brit. J. appl. Phys.*, **5**, 316–21 (*Sept.*, 1954).

The complex potential of a split cylindrical condenser is obtained by inversion of a known, simpler case. Expressions are obtained for the value of the electrostatic field at points on the axes of symmetry, the surface density of charge on a conductor and the capacitance of the condenser. The expressions obtained by Adams (1936), using another method, are deduced as one of three special cases for which tables and graphs are provided. The results should prove of value in the design of electrode systems for various purposes. A.

537.226.1.08

10156. Method of obtaining information on the internal dielectric constant of mixtures. G. P. de Loor. Letter in *Appl. sci. Res. B*, **3**, *No.* 6, 479–82 (1954).

Theoretical formulae always assume that the particle behaves as if it were in a liquid of d.c. ε' by itself; the various formulae make specific assumptions as to what is the value of ε', but the author describes a method of calculating ε' from the experimental results. Two examples of the method are given.

J. M. HOUGH

537.226.1.08

10157. An experiment on the dielectric constant of a gas. F. T. Worrell. *Amer. J. Phys.*, **22**, 375–8 (*Sept.*, 1954).

An experiment is described wherein the dielectric constant of air is measured in a student laboratory. By using a beat frequency method, rather than a direct comparison, precisions of the order of 0·01 to 0·001% are obtainable with ordinary equipment. Important instructional features of the experiment are mentioned. A.

537.226.1.08 : 621.317.335.3

10158. An absolute method of measuring dielectric constants by means of the quarter-wave Lecher circuit. V. M. Fedorov, I. V. Zhilenkov and A. N. Efremov. *Zh. éksper. teor. Fiz.*, **24**, *No.* 4, 466–9 (1953) *In Russian.*

The apparatus used was described in a paper by Zhilenkov and Efremov [Abstr. 5925 (1952)]. It has been found that formulae developed for the half-wave Lecher circuit for determining ε and $\tan\theta$ are also applicable for the quarter-wave circuit. The capacitance/unit-length magnitude for conductors at the end of the quarter-wave Lecher circuit has been found to be $C = \varepsilon/2(1 + \sin\phi)\ln[(l - r)/r]$. The method described is claimed to be suitable for determining ε and $\tan\theta$ of solid and liquid dielectrics in the metre and decimetre range. It is recommended to immerse well the leads of the circuit. F. LACHMAN

537.226.2

10159. On the influence of the temperature on the dielectric constant of liquids. R. Philippe. *Bull. Acad. Roy. Belgique Cl.Sci.*, **40**, *No.* 5, 544–56 (1954) *In French.*

Measurements on certain liquids have shown that they have an anomalous behaviour in that their dielectric constant increases with temperature. This has been noted for liquids as different as triethylcarbinol and methylal. It is shown that the explanation is specific for each liquid; for the first liquid it is due to a particular form of association and for the second to a freezing of certain rotational freedom.

J. M. HOUGH

537.226.2

10160. Dielectric behaviour of six normal primary alcohols at a wavelength of 9 cm between −60° and 60°. C. Brot. *C.R. Acad. Sci.* [*Paris*] **239,** 160–2 (*July* 12, 1954) *In French.*

The alcohols investigated were hexanol, heptanol, octanol, nonanol, decanol and dodecanol. The apparatus and experimental method used are described. It was found that at a given temperature ε' and ε'' crossed as the number of C atoms decreased. At the melting point ε^* showed a discontinuity for each alcohol; ε' changed from 2·30 or 2·40 to over 2·50, whilst ε'' also increased from ~ 0 to a value between 0·15 and 0·25. A. J. TAYLOR

537.226.2 : 621.317.335.3.029.64

10161. Measurement of refractive indices of air, nitrogen, oxygen, carbon dioxide and water vapour at 3360 Mc/s. W. Jasinski and J. A. Berry. *Proc. Instn Elect. Engrs III,* **101,** 337–42 (*Sept.*, 1954).

A sensitive and accurate method is described and critically examined to assess the systematic errors. It is based on the measurement of the change of the resonant frequency of a cavity resonator when evacuated and when filled with a gas. A frequency-modulation technique is used in conjunction with an oscillograph display. The standard deviation in the measurement of changes of the resonant frequency of the high-Q-factor cavity employed, was 77 c/s; this made possible the determination of $(n-1)$, where n is the refractive index, to four significant figures. This accuracy was achieved with the aid of a crystal-controlled frequency standard. The results for $(n-1)\times10^6$ at 0°c, 760 mm Hg are: CO_2-free air, $288{\cdot}2_6 \pm 0{\cdot}2$; N_2, $294{\cdot}4_7 \pm 0{\cdot}2$; O_2, $266{\cdot}1_7 \pm 0{\cdot}2$; CO_2, $494{\cdot}5_9 \pm 0{\cdot}35$; Water vapour (at 20°c and 10 mm Hg) $61{\cdot}3_1 \pm 0{\cdot}1$. The permanent electric moment of the water molecule was calculated to be $(1{\cdot}845 \pm 0{\cdot}001)\times10^{-18}$ e.s.u. The method of measurement is equally suitable for other microwave frequencies. A.

537.226.2

10162. Possible mechanism of ferroelectric domain boundary movement. T. Nakamura. Note in *J. Phys. Soc. Japan,* **9,** 425–6 (*May–June*, 1954).

The small coercive field (500 V/cm) observed for $BaTiO_3$ crystals [Abstr. 7654 (1953)] is explained by assuming small spiral steps between screw dislocations of Burger's vector, which are perpendicular to the (helicoidal) domain boundary. Movement of the boundary by revolutions of the steps occurs at lower stress than required with a plane boundary.

J. H. MASON

537.226.2

10163. Dielectric constant behavior of single-domain, single crystals of barium titanate in the vicinity of the Curie point. M. E. Drougard and D. R. Young. *Phys. Rev.*, **95,** 1152–3 (*Sept.* 1, 1954).

An abrupt transition is observed substantiating earlier conclusions that the transition is first-order. The Curie constant was found to be $1{\cdot}73\times10^5$ °c. The data indicate a thermal hysteresis effect. A.

537.226.3 : 548.7

10164. Application of the Hertzian absorption of iron oxides to the determination of the activation energy of their lattice defects. B. Hagène. Letter in *J. Phys. Radium,* **15,** 583–4 (*July–Aug.–Sept.*, 1954) *In French.*

Iron oxides show two activation energies for $v_{crit.}$ for their dielectric loss. One, $\sim 0{\cdot}10$ eV, corresponds to crystal defects, and the other, $\sim 0{\cdot}5$ eV, has an electronic origin. D. H. WHIFFEN

537.226.33 : 539.32

10165. Dielectric hysteresis and delayed elasticity. J. Granier and P. Caillon. *C.R. Acad. Sci.* [*Paris*] **238,** 2232–3 (*June* 9, 1954) *In French.*

Experimental results for polyvinyl chloride. The dielectric hysteresis is consistent with Wagner's theory, whereas the mechanical measurements are to a first approximation in agreement with Nutting's law.

C. A. HOGARTH

537.226.8.08 : 621.317.333.6.029.62

10166. A breakdown cell for measuring the dielectric strength of solids at 100 megacycles. L. J. Frisco and J. J. Chapman. *Rev. sci. Instrum.*, **25,** 733–7 (*Aug.*, 1954).

A liquid-filled cell for measuring the dielectric strength of solids at 100 Mc/s is described. The cell consists of a high-voltage resonant circuit and a built-in voltage measurement probe. The calibration of the voltage measurement network is fully discussed.

A.

ELECTRIC CONDUCTION . CURRENTS 537.3

537.31 : 621.316.8

10167. Charge-transport apparatus as a high ohmic resistance. W. Kossel, F. Leonhard and P. Volk. *Z. angew. Phys.*, **6,** *No.* 5, 213–15 (1954) *In German.*

A method of obtaining stable high resistances of the order of $10^{12}\ \Omega$ using a mechanical device for transferring charge from one point to another. If a conductor such as a metal sphere of capacitance C is used to transfer charge through a potential difference U, n times per second, the mean current is nCU, so that the effective resistance of the arrangement is $R = 1/nC$. If $n = 1$ and $C = 1$ then $R = 1$ e.s.u. $= 9\times10^{11}\ \Omega$. The experimental realization of this is described. M. R. HOPKINS

537.311.1

10168. Diffusion on the Fermi surface and the conductivity of metals. F. J. Blatt. Note in *J. Phys. Soc. Japan,* **9,** 440 (*May–June*, 1954).

It is pointed out that Toda's evaluation of the Lorenz number of an ideal metal at low temperatures [Abstr. 6037 (1953)] is based on invalid methods of approximation, and that a correct use of Toda's procedure leads to results in agreement with those obtained by Sondheimer [Abstr. 8687 (1950)].

E. H. SONDHEIMER

537.311.1

10169. Diffusion on the Fermi surface. M. Toda. Note in *J. Phys. Soc. Japan,* **9,** 440–1 (*May–June*, 1954).

Further discussion (see preceding abstract) of the interpretation of conduction in metals in terms of diffusion processes on the Fermi surface [see also Abstr. 5777 (1952)]. The same method is used to

calculate the viscosity of a degenerate Fermi gas, with applications to liquid He^3. E. H. SONDHEIMER

537.311.3 : 538.632

10170. The electrical properties of the intermetallic compound Mg_3Sb_2. G. BUSCH, F. HULLIGER AND U. WINKLER. *Helv. phys. Acta*, **27**, *No.* 3, 249–58 (1954) *In German.*

Polycrystalline high-purity α-Mg_3Sb_2 was prepared, and measurements of conductivity, Hall effect and thermoelectric power carried out. The energy gap width is 0·82 eV, and the mobility of holes is greater than that of electrons. W. M. LOMER

537.311.3 : 669.21.26 : 621.316.8

10171. The dependence of gold-chromium standard resistors on loading. A. SCHULZE AND D. BENDER. *Z. angew. Phys.*, **6**, *No.* 3, 132–6 (1954) *In German.*

Extensive measurements on resistors in glass envelopes showed a curious behaviour. Further work showed that these wires have a Peltier effect when sweated to Pt. The thermoelectric power can vary in the range $1–2\times10^{-6}$. It is shown that filling the glass bulb with He has a beneficial effect on account of the good thermal conductivity of this gas. E. H. DOCK

537.311.32

10172. Conductivity induced in polytetrafluoroethylene by X-rays. J. F. FOWLER AND F. T. FARMER. Letter in *Nature* [*London*] **174**, 136–7 (*July* 17, 1954).

Measurements on a specimen in a vacuum chamber show the usual temperature relationship, $\sigma \propto \exp(-W/kT)$, and it is found that $W = 1·1$ eV before irradiation and 0·5 eV during irradiation. The dose-rate dependence indicates a distribution of electron traps which is exponential below the conduction band. The conductivity decays very slowly with time, taking 6 hr to fall to 1/10 at 80°C, but its magnitude during irradiation is less by a factor of 10 than for polyethylene. It is inferior to Perspex and amber for ionization chambers which have to withstand large doses of radiation. F. T. FARMER

537.311.33

10173. The investigation of the energetic spectrum of an electron in an ionic semiconductor for superposed electric and magnetic fields. M. I. KLINGER. *Zh. éksper. teor. Fiz.*, **26**, *No.* 2, 159–67 (1954) *In Russian.*

A theoretical paper investigating the spectrum due to electron interaction with the optical vibrations of an ionic semiconductor (weak coupling approximation). The effective mass of the current carrier depends on the fields and also on the temperature. The phonon distribution is discussed. W. BARDSLEY

537.311.33

10174. The investigation of the polarization of a semiconductor for superposed electric and magnetic fields. M. I. KLINGER. *Zh. éksper. teor. Fiz.*, **26**, *No.* 2, 168–72 (1954) *In Russian.*

Continues from preceding abstract, and investigates the fundamental self-consistent condition of polarization. Also the question of "breaking down" of the polarization caused by the electric field. W. BARDSLEY

537.311.33

10175. Saturation photocurrents in semiconductors. F. STÖCKMANN. *Z. Phys.*, **138**, *No.* 3–4, 404–10 (1954) *In German.*

Two possible mechanisms are discussed. For electron and hole conduction, saturation can occur which is not space-charge limited, e.g. in Ge; but in other cases, e.g. CdS, saturation is limited by space charge. G. F. J. GARLICK

537.311.33

10176. Properties of point contacts on cobaltite. G. G. E. LOW. Note in *Proc. Phys. Soc.* [*London*] *B*, **67**, 589–90 (*July*, 1954).

Experiments are described which suggest that the symmetrical non-linear voltage-current characteristics obtained with tungsten point contacts on cobaltite (CoAsS) of resistivity 1 ohm cm, are due to the heat dissipation in the vicinity of the contact and consequent reduction in the spreading resistance. C. A. HOGARTH

537.311.33

10177. On the semiconducting properties of cuprous oxide. IX. Hall effect measurements at low temperatures. P. SCHMIDT. *Ann. Phys.* [*Leipzig*] **14**, *No.* 6–8, 265–89 (1954) *In German.*

For Pt VIII, see Abstr. 7413 (1954). Measurements of electrical conductivity and Hall coefficient on many specimens of Cu_2O prepared under various conditions of temperature and O_2 pressure and after quenching from about 960°C. Anomalous results on the conductivity type of some specimens were found. Suggested that a surface layer of anomalous conductivity type may influence experimental results. C. A. HOGARTH

537.311.33

10178. On the semiconducting properties of cuprous oxide. X. Observations of the electrical conductivity on disturbing the thermodynamic equilibrium between 600°C and 1000°C within and beyond the stability region of Cu_2O. G. BLANKENBURG. *Ann. Phys.* [*Leipzig*] **14**, *No.* 6–8, 290–307 (1954) *In German.*

The stability regions of CuO and Cu_2O in terms of temperature T and oxygen pressure P_{O_2} were determined. By varying T and P_{O_2} hysteresis effects were obtained when the temperature was varied cyclically in the region 600 to 1000°C and at very low pressures of oxygen. The relaxation times for the chemical processes taking place are determined and discussed. C. A. HOGARTH

537.311.33

10179. On the semiconducting properties of cuprous oxide. XI. The behaviour of cuprous oxide in the stability range of cupric oxide. G. BLANKENBURG. *Ann. Phys.* [*Leipzig*] **14**, *No.* 6–8, 308–18 (1954) *In German.*

Detailed discussion of the chemical changes taking place during changes in T and P_{O_2}. C. A. HOGARTH

537.311.33

10180. A note on the effect of temperature gradients at point contacts on germanium. H. K. HENISCH AND P. M. TIPPLE. Letter in *Proc. Phys. Soc.* [*London*] *B*, **67**, 651–2 (*Aug.*, 1954).

The d.c. reverse resistance is found to increase with increasing temperature gradient. The result is confirmed by a new experiment and the mechanism of the effect is discussed. C. A. HOGARTH

537.311.33 : 539.234

Evaporated multiple layers with semiconductor properties. *See Abstr.* 10559

537.311.33

10181. The barrier-layer capacitance of the indium–germanium alloy rectifier. H. U. HARTEN, W. KOCH, H. L. RATH AND W. SCHULTZ. *Z. Phys.*, **138,** *No.* 3–4, 336–44 (1954) *In German.*

The Schottky theory of barrier-layer capacitance is outlined, and measurements are made on In alloy Ge diodes. The modifications brought about by injection effects are discussed with diffusion length as a parameter. C. A. HOGARTH

537.311.33

10182. On the relation between the sum of donor and acceptor concentration and lifetime in single crystal germanium. P. RANSOM AND F. W. G. ROSE. Note in *Proc. Phys. Soc.* [*London*] *B,* **67,** 646–50 (*Aug.*, 1954).

It is shown that there is a relation between the sum of the donor and acceptor concentrations, the trap density, and the hole lifetime in *n*-type single crystal germanium. Agreement with experiment is good.

C. A. HOGARTH

537.311.33 : 548.7

10183. On the influence of special lattice defects on the electrical properties of germanium. K. BLANK, D. GEIST AND K. SEILER. *Z. Naturforsch.*, **9a,** 515–20 (*June*, 1954) *In German.*

Under highly pure conditions the electrical conductivity of very hot (800°C) Ge shows no change after plastic deformation. The lifetime becomes practically zero after the deforming treatment. The changes taking place in the Ge are discussed.

C. A. HOGARTH

537.311.33

10184. Electronic conduction of naphthalene single crystals. H. PICK AND W. WISSMAN. *Z. Phys.*, **138,** *No.* 3–4, 436–40 (1954) *In German.*

Naphthalene is found to be an electronic semiconductor. The energy gap is 3·8 eV, but because of the large value of σ_0 in the equation $\sigma = \sigma_0 \exp(-E/kT)$ (i.e. 10^{13} ohm^{-1} cm^{-1}) the conductivity at 60°C is readily measurable. Since the concentration of charge carriers is inevitably small these results imply a high value for the carrier mobility. The effects of oxygen treatment on the crystals are examined.

C. A. HOGARTH

537.311.33

10185. Some investigations on the electrical properties of hexagonal selenium. L. M. NIJLAND. *Philips Res. Rep.*, **9,** 259–94 (*Aug.*, 1954).

A survey of recent literature on selenium is given. The resistivity of polycrystalline, hexagonal selenium can be lowered by halogens and can be raised by thallium. No reliable data on fundamental quantities like hole densities and mobilities are found in the literature. Investigations on these subjects are described in this paper. A method of purifying selenium by evaporation near its melting point is developed. High-frequency measurements of the conductivity of pure and of thallium-doped selenium samples comply with the assumption that polycrystalline selenium consists of rather well-conducting crystals embedded in badly conducting layers of more or less amorphous selenium. Thallium increases the resistance of the layers and does not or only slightly affect the resistance of the crystals. Measurements of the Hall effect and of the shunt resistivity *v.* frequency of pure and of bromine-containing selenium samples point to the same layer structure. Bromine does not affect the resistivity of crystals but lowers that of the layers. Single crystals prepared in a bromine-containing atmosphere have the same resistivities as pure crystals. The last part contains a discussion of the experimental results and points to a model with both amorphous and crystallized parts in the same selenium chain. A.

537.311.33

10186. On the conductivity of silicon. W. HEYWANG, M. ZERBST AND F. BISCHOFF. Note in *Naturwissenschaften,* **41,** *No.* 13, 301–2 (1954) *In German.*

Conductivity *v.* temperature measurements for very pure Si on both poly- and mono-crystalline specimens. In the usual conductivity equation $\sigma = Ae^{-E/2kT}$, E is 1·12 eV and A is $9{\cdot}1 \times 10^3$ ohm^{-1}. cm^{-1} ± 10%. The electron mobility in *n*-type specimens is 1200 ± 100 cm^2. V^{-1}. sec^{-1}. C. A. HOGARTH

537.311.33

10187. On the influence of adsorbed oxygen on the conductivity of zinc oxide crystals. G. HEILAND. *Z. Phys.*, **138,** *No.* 3–4, 459–64 (1954) *In German.*

Measurements of the conductivity of *n*-type ZnO as function of adsorbed O_2 are given, and are interpreted in terms of layers of surface charge associated with free conduction electrons. W. M. LOMER

537.311.33

10188. The effect of hydrogen on the conductivity and luminescence of zinc oxide crystals. E. MOLLWO. *Z. Phys.*, **138,** *No.* 3–4, 478–88 (1954) *In German.*

ZnO crystals show a reversible rise in conductivity by heating in hydrogen. From the conductivity change with time a diffusion process is apparent, and the diffusion constant is measured at different temperatures. At room temperature, the green luminescence of the crystals is quenched if the hydrogen pressure is high. This effect is also reversible and the diffusion constant for the quenching agent is the same as that for the conductivity change.

G. F. J. GARLICK

537.311.33

10189. On the influence of cathode sputtering in high vacuum on the rectifier action of germanium. H. BALDUS. *Z. angew. Phys.*, **6,** 241–6 (*June*, 1954) *In German.*

It is shown that cathode-sputtering reduces the rectification of point contacts on *n*-type Ge (measured in high vacuum) but that etching restores it. The experiments suggest that the rectification in Ge arises at the interface between the *p*-type surface layer and the *n*-type bulk material, and that the whisker is relatively unimportant. C. A. HOGARTH

537.311.33

10190. Influence of mechanical pressure on barrier height in galena rectifiers. J. N. DAS AND V. G. BHIDE. Letter in *Curr. Sci.*, **23,** 185–6 (*June*, 1954).

A platinum point contact was applied to a galena crystal with a load increasing from 30–150 g. wt. The

"barrier height" inferred from the form of the d.c. characteristic in the easy-flow direction increased from 1·28 eV to a max. of 1·83 eV at 110 g. wt. and then decreased to 0·32 eV. The spreading resistance decreased from 82 Ω to a min. of 16 Ω at 110 g. wt. and then rose to 68 Ω. F. F. ROBERTS

537.312.5

10191. Negative photoconductivity of cuprite. A. N. KRONGAUS AND V. K. LYAPIDEVSKIĬ. *Zh. éksper. teor. Fiz.*, **26**, *No.* 1, 115–19 (1954) *In Russian.*

Negative photoconductivity, i.e. increasing resistivity with illumination, has been observed with selenium, molybdenum and cuprite. A description of the experimental investigation of this effect is given, undertaken on monocrystals of mineral cuprite by means of square-wave light pulses. It is shown generally that negative photoconductivity increases with illumination and voltage polarization. Results are reproduced in several curves, plotting light and dark current as varying short- and long-term exposure, with stationary dark and light-current values as upper and lower limits, and showing relationship between applied voltage and photoconductivity which reverts to positive at low voltages. The polarity of photoconductivity also depends on the spectral character of the light source; thus the ultraviolet end of the spectrum is more absorbed by the crystal and yields positive photoconductivity. A. LANDMAN

537.312.5

10192. On the photoelectric behaviour of X-ray irradiated NaCl crystals. I. TARJÁN. *Acta phys. Hungar.*, **3**, *No.* 3–4, 303–21 (1954) *In German.*

The previously established characteristics of photoconduction in X-ray coloured NaCl are confirmed and a new effect investigated, denoted as due to "colloid-excitation." The latter increases with X-ray dosage and is increased by irradiation with red light before measurement. G. F. J. GARLICK

537.312.5

10193. Towards the kinetic formation and relaxation of non-equilibrium current carriers during the illumination of a semiconductor. E. I. ADIROVICH AND V. G. KOLOTILOVA. *Zh. éksper. teor. Fiz.*, **26**, *No.* 3, 281–92 (1954) *In Russian.*

A theoretical paper which investigates the kinetics of the production and disappearance of photoelectrons and photoholes in non-equilibrium concentrations in a bipolar semiconductor. The stationary distribution is examined. The linearization of the equations for certain limiting conditions and the requirements of quasi-neutrality are described. W. BARDSLEY

537.312.5 : 548.7

10194. Observations on the work of B. Seraphin: "The influence of temperature and oxygen on the rise and decay of photoconductivity of single crystals of CdS." G. HÖHLER. *Ann. Phys.* [*Leipzig*] **14**, *No.* 6–8, 426–7 (1954) *In German.* See Abstr. 4549 (1954).

537.312.6

10195. Minimum in the electrical resistance of metals at low temperatures. A. B. BHATIA. *Phys. Rev.*, **95**, 914–16 (*Aug.* 15, 1954).

A discussion is given of the effect on the electrical properties of normal metals at low temperatures of the same interaction as that invoked by Fröhlich and Bardeen in the theory of superconductivity. In particular it appears possible to explain qualitatively the resistance minimum experimentally observed in slightly impure metals, though a final decision must await an improvement in the general mathematical techniques for dealing with the Fröhlich–Bardeen interaction. A.

537.312.62

10196. Influence of condensation at low temperatures on the electrical resistance and superconduction of various metals. W. BUCKEL AND R. HILSCH. *Z. Phys.*, **138**, *No.* 2, 109–20 (1954) *In German.*

Thin metal films were condensed from the vapour on to quartz at 4°K. Al, Zn, In, Tl, Pb, Hg and Sn showed an abnormally high residual resistivity which disappeared on tempering. The superconducting transition temperature was variously affected; an increase by a factor 2·26 for Al and a decrease by 0·94 for Hg were the extremes. Ga and Bi were more strongly affected. Their residual resistance increases on tempering; T_c for Ga is raised from 1·07 to 8·4°K, and Bi, not normally superconducting, has $T_c = 6·0$°K. W. M. LOMER

537.312.62 : 534.22

10197. Velocity of sound in superconducting tin. C. F. SQUIRE. *Phys. Rev.*, **95**, 1126–8 (*Sept.* 1, 1954).

The ultrasonic pulse method has been used to measure the velocity of 10 Mc/s sound waves in polycrystalline tin from 295 to 2°K. The superconducting state has no effect (± 0·3%) on the velocity and attenuation of longitudinal and of transverse waves. The value of θ_D computed from these velocity measurements at the very low temperature is 210°K. A.

537.312.62 : 548.736.3

The structure of superconductors—the Bi–Pd system. *See Abstr.* 10664

537.312.9

10198. The effect of cold-work on the electrical resistivity of alloys and the law of recovery. J. O. LINDE. *Appl. sci. Res. B*, **4**, *No.* 1–2, 73–86 (1954).

The change in resistivity due to cold-work has been determined for a number of binary alloy series having copper, silver or gold as basic metal. The effects observed are very different in the different alloy systems. A change as large as 42% of the total resistivity is found in one case. Alloys from the systems gold–chromium and gold–iron show a decrease of resistivity when cold-worked. In addition to the binary series, some alloys containing three or four components have also been investigated, and on the basis of the results obtained the question of the influence of the different solutes upon the change of resistivity is discussed. Results are given regarding the recovery of the resistivity changes as a function of time for different annealing temperatures. The resistivity change $\Delta\rho$ as a function of temperature T and time τ is found to obey the law $\Delta\rho = c\tau^n \exp(-nE/RT)$, where n is a number of the order 0·1–0·4 and E is the activation energy of the process; R is the gas constant, and c a quantity of proportionality. Alloys belonging to the following binary systems have been investigated: Cu–Al, Cu–Si,

Ag–Al, Ag–Mn, Ag–Sn, Au–Al, Au–Cr, Au–Mn, Au–Fe and Au–Sn, and the following multi-component systems: Au–Mn–Cr, Au–Mn–Cr–Fe and Au–Al–Cr. A.

537.32 : 536.7

10199. Irreversible thermodynamics of thermoelectricity. C. A. Domenicali. *Rev. mod. Phys.*, **26**, 237–75 (*April*, 1954).

A detailed treatment, using the Onsager reciprocity relations, based upon electrochemical potentials. The first part deals with isotropic media; the treatment is later extended to anisotropic media. Comparison is made with the methods of Kelvin, Bridgman, Ehrenfest and Rutgers, Kohler, Meixner, and Meissner. Appendices deal in some detail with applications of the theory to particular systems and connections with experimental methods. F. E. HOARE

537.321

10200. Thermoelectric power and electron scattering in metal alloys. C. A. Domenicali and F. A. Otter. *Phys. Rev.*, **95**, 1134–42 (*Sept.* 1, 1954).

The thermoelectric power of a metal depends on the details of how the current carriers in the metal are scattered by the various deviations of the crystal from a perfect lattice. A semiempirical theory of thermoelectric power in metal alloys is described, which is based on a formula due to Mott and others. The theory relates absolute thermopower to the energy dependence of the scattering cross-section $Q_i(\varepsilon)$ of lattice imperfection, and deduces numerical values for the first few "scattering coefficients" in a Taylor expansion of $Q_i(\varepsilon)$ about the Fermi level μ_0 in the pure solvent metal. The few known empirical "rules" of thermoelectric power in binary alloys of Cu, Ag and Au, of alkali metals, and of Al are interpreted in terms of these scattering coefficients. The correlation with high-temperature thermoelectric properties of such alloys is shown to be quite satisfactory, but the low-temperature properties present several difficulties which cannot be properly discussed without further extensive experiments at very low temperatures. The usefulness of thermoelectricity as a tool for studying the nature of lattice imperfections is discussed briefly. A.

537.323

10201. The thermoelectric properties of metal–ammonia solutions. I. The thermoelectric power of sodium and potassium at — 33°. J. F. Dewald and G. Lepoutre. *J. Amer. Chem. Soc.*, **76**, 3369–76 (*July* 5, 1954).

The thermoelectric properties of sodium and potassium solutions in liquid ammonia at — 33° have been studied over the concentration range from 0·002 M to saturation. Experimental procedures are outlined, with particular emphasis on methods of preparing solutions of maximum stability. The data for the concentrated solutions are shown to be in strikingly good accord with the predictions based on a degenerate electron gas model. In the dilute range of concentration, where one ordinarily expects the best agreement between theory and experiment, a marked anomaly is observed. The thermoelectric power increases with dilution almost exactly twice as rapidly as theory predicts it should. A.

537.323

10202. Thermoelectric power of monovalent metals at high temperature. P. G. Klemens. Letter in *Phil. Mag.*, **45**, 881–2 (*Aug.*, 1954).

It is pointed out that if the Fermi energy of potassium is taken to be different from the value deduced from the free electron model, the theoretical expressions for thermoelectric power can be made to agree well with experiment and the values are no longer necessarily anomalous as suggested by MacDonald and Roy [Abstr. 1344 (1954)]. C. A. HOGARTH

537.323 : 537.311.33

10203. The effects of heat flow on thermoelectric power in semiconductors. J. E. Parrott. Letter in *Proc. Phys. Soc.* [*London*] *B*, **67**, 587–8 (*July*, 1954).

The effects due to conduction of heat by the lattice vibrations are considered from a more physical approach than the formal treatments due to Gurevich and to Frederikse. Reasonable agreement with experiment is obtained. C. A. HOGARTH

537.363 : 541.182.42

10204. An improved technique for the micro-electrophoresis of oil drops. D. A. Smith. *Brit. J. appl. Phys.*, **5**, 325–8 (*Sept.*, 1954).

A new technique is described for preparing hydrocarbon dispersions by the "steam-jet" method without risk of atmospheric contamination. A modified cylindrical micro-electrophoresis cell in conjunction with a conventional apparatus is used to establish conditions for reproducible mobility measurements. Measurements were made between 2½ and 7 hr after the preparation of the dispersion using, as dispersion medium, sodium chloride or pyroborate solution at a controlled pH. Values obtained for the mobilities of cyclohexane and *n*-hexane at 24·9°C in 0·01 N Na^+ were, at pH 9·0, 2·94 and 3·52 μ per sec per V per cm respectively; at pH 11, 3·22 and 3·90 μ per sec per V per cm; and in 0·1 N Na^+ at pH 9·0, cyclohexane gave the value 2·69 μ per sec per V per cm. A.

ELECTRIC DISCHARGES 537.52

537.521.7 : 621.3.015.5 : 621.315.618

10205. The electrical breakdown of pre-stressed air at atmospheric pressure. D. R. Hardy and H. Wroe. *Brit. J. appl. Phys.*, **5**, 335–9 (*Sept.*, 1954).

Time lags to breakdown are measured for surge voltages applied to gaps, which are irradiated with radium, and across which exist steady fields, both uniform and non-uniform. An appreciable difference in time lags for a given overvoltage is observed as the ratio of approach to surge voltage is varied. A.

537.523.4

10206. Breakdown of small air gaps. I. E. Balygin. *Zh. éksper. teor. Fiz.*, **26**, *No.* 1, 98–106 (1954) *In Russian.*

Impulse voltage breakdown of sphere gaps 0·2 to 1 mm long was investigated under normal atmospheric conditions at different values of the gap discharge

current. The oscillograms obtained show the existence of two different types of gap discharge: one type is characterized by frequent, small-amplitude voltage peaks leading to partial breakdown while the de-ionization of the gap follows an exponential law, and the other by the constancy of the voltage across the electrodes despite the fast decay of the applied impulse. Relations between the breakdown field strength and the pre-discharge gap current are derived.

E. M. DEMBINSKI

537.523.4

10207. Measurement of the current during the formative time lag of sparks in uniform fields in air. H. W. BANDEL. *Phys. Rev.*, **95**, 1117–25 (*Sept.* 1, 1954).

The current in a parallel plane gap during the long formative time lags of sparks in air has been measured from 10^{-6} A a few μsec after application of the voltage up to 10^{-2} A just before breakdown, for time lags between 10 and 100 μsec. Calculations for the increase of $\exp\left(\int_0^d \alpha dx\right)$ due to field distortion by positive ions are in good agreement with an observed rapid increase of current shortly before breakdown. The Townsend discharge is shown to be spread over the whole electrode surface in contrast to the filamentary nature of the final spark. The photosensitivity of the cathode surface has been found to decrease following collection of positive ions. The conditioning of the electrodes observed by Fisher and Bederson is believed to be due to such a decrease in γ_p. Some gain has been made toward a theoretical solution for the growth of the Townsend discharge. Working with an integral equation and taking due care with integration limits, has established the range of validity of the existing solution and yielded another approximate solution; from these, exact solutions for the limiting cases of only one γ are obtained. There is over-all agreement between theory and experiment within limits of error except for an observed delay in the initial current rise. To explain this requires the consideration of mechanisms, involving creation and transmission of active photons, which could cause a delay of the order of an electron crossing time. A.

537.523.4 : 621.3.015.5

10208. Formative time-lag studies with high-frequency discharges. A. W. BRIGHT AND H. C. HUANG. *Instn Elect. Engrs Monogr. No.* 105, 4 *pp.* (*Aug.* 16, 1954) [To be republished in *Instn Elect. Engrs Proc. C*].

Experiments with discharges between non-uniform electrodes at frequencies in the region of 1 to 15 Mc/s are described. It was found that, above a certain critical frequency, the discharge was able to cross the gap completely, whereas the discharge at d.c. or 50 c/s with the same electrodes would take the form of a localized corona envelope. By using pulse techniques, it was possible to measure the formative time-lags for h.f. discharges, using concentric-cylinder and parallel-wire electrodes. A lowering of the breakdown voltage of some 13% was observed to take place above the critical frequency. A tentative qualitative explanation is proposed of some of the observed results. A.

537.523.5

10209. On the theory of cathode falls in luminous arcs. A. BAUER. *Z. Phys.*, **138**, *No.* 1, 35–55 (1954) *In German.*

Cathode fall for thermionic and field-emission-maintained arcs is discussed with reference to the contraction theory of the arc and experimental data.

C. G. MORGAN

537.523.5

10210. The double electrode a.c. arc. A comparative investigation of the light decay in steady carbon arcs. F. ROST AND H. HAUSNER. *Z. angew. Phys.*, **6**, 275–9 (*June*, 1954) *In German.*

By following the temporal variations of the ratios of the light intensities of various Fe, Ni and Si spectral lines over times $\sim$ 100 secs, the behaviour (stability, sensitivity, etc.) of various arc arrangements could be assessed. The case of SiO_2 contaminated with 0·005% to 1% of Fe_2O_3 is treated in some detail. J. D. CRAGGS

537.523.5 : 621.325

10211. New development work on Beck arcs and Beck arc lamps. W. FINKELNBURG. *Z. angew Phys.*, **6**, *No.* 5, 239–40 (1954) *In German.*

Describes experimental work on Beck (cored-electrode) arcs. Details of an automatic self-adjusting arc are given, together with data on brightnesses.

J. D. CRAGGS

537.525.3

10212. Dependence of the threshold potential in silent electric discharge on the nature of the electrode surface. S. R. MOHANTY. Letter in *J. sci. industr. Res.*, **13 B**, 145 (*Feb.*, 1954).

Data are given to illustrate the connection between the breakdown voltage and the surface conditions in an ozonizer tube. J. D. CRAGGS

537.525.3

10213. Condition of streamer formation in a.c. 'silent' discharges. S. R. KHASTGIR AND C. M. SRIVASTAVA. Letter in *Sci. and Culture*, **19**, 506–7 (*April*, 1954).

A brief general discussion of electrodeless a.c. corona discharges with reference to the streamer theory of gaseous electrical breakdown. J. D. CRAGGS

537.525.4

10214. Temperature dependence of fluctuation of sparking voltage in a gas discharge tube. M. HAYASHI AND Y. MIYOSHI. Note in *J. Phys. Soc. Japan*, **9**, 432–4 (*May–June*, 1954).

Describes measurements of the fluctuations of breakdown voltages in a hydrogen discharge between tungsten electrodes (spaced 0·6 mm apart) at 20 mm Hg pressure. The fluctuations vary with temperature (−80 to +140°C) in such a manner as to suggest that an adsorbed gas layer on the cathode is responsible for the effect. J. D. CRAGGS

537.525.72

10215. On the occurrence of negative and positive Joshi effects in the electrostatic and electromagnetic forms of self-maintained a.c. discharges in iodine vapour. N. SUBRAHMANYAM AND N. A. RAMAIAH. *Z. Phys.*, **138**, *No.* 2, 151–66 (1954) *In German.*

Gives detailed exptl. data referring to the effect of external irradiation on the characteristics of high-

voltage a.c. corona (electrodeless ozonizer tube discharges). The mechanism of the discharges is discussed. There are 32 references. J. D. CRAGGS

537.525.72

10216. The positive Joshi effect in oxygen under electrodeless discharge. S. R. MOHANTY, J. JAYARAMAN AND G. V. G. KRISHNA RAO. *J. Phys. Soc. Japan*, **9**, 576–9 (*July–Aug.*, 1954).

The Joshi effect $\pm\Delta i$ has been studied in oxygen, in the visible, as a function of the applied potential V under electrodeless "sleeve" excitation. The positive effect $+\Delta i$ sets in well below the breakdown "threshold potential" V_m, increases with V to a maximum at a limiting potential V_l near V_m, and decreases thereafter; it changes sign (to the negative effect $-\Delta i$) at an inversion potential V_i. Above V_i, $-\Delta i$ increases with V. The initial increase in $+\Delta i$ is the consequence of enhanced photoelectron emission due to diminution, under fields F, in the surface work function ϕ in proportion to $\sqrt{F}$. The subsequent diminution in $+\Delta i$ and inversion are due to simultaneous occurrence of $-\Delta i$ which sets in near V_m and increases rapidly with V. A.

537.525.8

10217. The electrode surface as the seat of ageing in the production of the Joshi effect. S. R. MOHANTY, T. D. PRASADA RAO AND R. RAMAIAH. Letter in *J. sci. industr. Res.*, **13B**, 144 (*Feb.*, 1954).

A brief note on surface effects in a.c. "electrodeless" corona discharges in oxygen. J. D. CRAGGS

537.525.8

10218. Oscillographic study of the negative Joshi effect. P. S. V. SETTY AND K. WALI. Letter in *J. sci. industr. Res.*, **13B**, 302–4 (*April*, 1954).

Describes experiments on the Joshi effect in iodine vapour. The results are discussed in the light of mechanisms proposed by various authors. The discharges studied are the usual low pressure electrodeless a.c. coronas. J. D. CRAGGS

537.525.8

10219. On the energy transitions in organic substances in luminous discharges. H. SCHÜLER. *J. Phys. Radium*, **15**, 524–5 (*June*, 1954) *In French.*

A general brief discussion of certain processes relating to the physical chemistry of glow discharges through complex gases. A diagram of a special tube is shown. Various phenomena are mentioned, e.g. the formation of hydrazine and the localized production of dibenzyl in the regions of striations in interrupted discharges. J. D. CRAGGS

537.525.8

10220. The measurement of electron densities in the plasma of a decaying glow discharge. W. ECKHARDT, R. HONERJÄGER AND E. SCHULZ-DU BOIS. *Z. angew. Phys.*, **6**, 246–9 (*June*, 1954) *In German.*

Describes a microwave cavity method for investigating the decay of ionization in a glow discharge, which is recurrent and pulsed. A block diagram and schematic oscillograms are given. J. D. CRAGGS

537.525.8

10221. Temperature measurement in a hollow-cathode discharge. R. SCHOEN AND J. R. HOLMES. Letter in *J. opt. Soc. Amer.*, **44**, 502–3 (*June*, 1954).

A Schüler source containing nitrogen or nitrogen–helium mixtures was used for temperature measurements of discharges. In nitrogen, "rotational temperatures" were measured from N_2^+ bands and in the mixtures these could be compared with Doppler width temperatures from the helium 6678 and 5015 Å lines. The temperatures varied from 100–420°K, approximately. J. D. CRAGGS

537.525.8

10222. On several phenomena in inductively coupled electrodeless high frequency gas discharges with superimposed magnetic fields. H. NEUERT, H. J. STUCKENBERG AND H. P. WEIDNER. *Z. angew. Phys.*, **6**, 303–10 (*July*, 1954) *In German.*

A continuation of previous related work by Neuert *et al.* [e.g. Abstr. 1077 (1949)]. The paper deals with low pressure ($1–20\times10^{-3}$ mm Hg) discharges at frequencies varying from 20–70 Mc/s. Discharge characteristics are presented for longitudinal and cross magnetic fields. Details of a u.h.f. cavity method for electron density measurements are also given, with results. J. D. CRAGGS

537.525.8 : 538.561

10223. Low-frequency oscillations in the positive column of the glow discharge. M. E. GERTSENSHTEĬN AND V. V. POTEMKIN. *Zh. éksper. teor. Fiz.*, **24**, *No.* 6, 643–51 (1953) *In Russian.*

It has been shown that longitudinal electric waves in the positive column of a discharge are always accompanied by pulsations in the current intensity. By assuming simultaneity of waves and pulsations it becomes possible to explain the spatial periodicity of discharge luminescence and the phenomenon of moving luminescent layers. The simultaneity is confirmed by the analysis of oscillograms of the probe voltage. The theory proposed stipulates, in agreement with experimental data, that the periodic luminescent structure must disappear at low gas pressures. An amplifier with feedback is an equivalent model of the discharge in relation to oscillations. The analysis of this model yields the existence of several generating regions as well as the dependence of frequency on the anode-cathode distance; this agrees quantitatively with experiment. Another theoretical result is that the wave energy flux is always directed from cathode to anode, irrespective of the phase velocity. F. LACHMAN

537.527 : 538.56

10224. Self-excitation of auto-oscillations in a gas discharge at high pressure. M. E. GERTSENSHTEĬN. *Zh. éksper. teor. Fiz.*, **26**, *No.* 1, 57–63 (1954) *In Russian.*

Interaction between sound and electron waves in gas-discharge plasma is considered. This is the continuation of a series of papers initiated by the author in 1952 [Abstr. 3677 (1954)]. A theoretical possibility was demonstrated of the self-excitation of oscillations within a definite frequency range in the positive column of gas discharge having a directed common motion of electrons. The analysis begins from a general linearized kinetic equation for the distribution of particles as a function of position, velocity and time, taking into account the collisions between the particles. It is shown that under certain conditions a plane wave of electron gas can be

obtained which can be resolved into an e.m. wave and a wave of particles. Forces of interaction between these two waves can be determined. The phase velocity in some cases is higher than the velocity of sound. The formula obtained allowed the conditions to be determined at which the generation of oscillations is possible at a given gas pressure. N. S. JAPOLSKY

537.527.5

10225. An investigation of the emergence of a plasma stream from a high-power arc. R. WEISS. *Z. Phys.*, **138**, *No.* 2, 170–82 (1954) *In German.*

By a suitable arrangement (two alternatives are given) of a heavily loaded arc, running in a water-turbine system as described in earlier papers by the Kiel workers, it is possible to produce an emergent jet of plasma. The properties of this plasma stream (Plasmastrahl) are investigated, e.g. the temperature distribution in it. J. D. CRAGGS

537.528 : 621.3.015.5 : 621.315.615.2

10226. Duration of the discharge in liquid insulating materials. I. E. BALÝGIN. *Zh. tekh. Fiz.*, **24**, *No.* 2, 337–47 (1954) *In Russian.*

The formation of the discharge in liquid dielectrics is sometimes clearly divided into two stages, an initiating and a completing stage. For the three liquids tested, namely, transformer oil, castor oil and distilled water, the second stage lasts $1–2\times10^{-7}$ sec. Oscillograms taken of the discharge initiated by well-defined voltage pulses show that the increase of the field strength applied reduces the statistical discharge delay. The breakdown of transformer oil and distilled water is nearly instantaneous after a discharge delay of about 1 μsec, remaining constant up to very high overvoltages across the discharge gap. There is no distinct pre-discharge stage, such as occurs with air gaps. These characteristics refer to a positive point-plate arrangement. The negative point-plate oscillograms are analogous and the formation time is 10^{-7} sec. The corresponding time for castor oil is 2×10^{-7} sec. B. F. KRAUS

537.529

10227. Electrical excitation as a primary effect in dielectric breakdown. K. W. BÖER AND U. KÜMMEL. *Ann. Phys.* [*Leipzig*] **14**, *No.* 6–8, 341–62 (1954) *In German.*

The dependence of breakdown on field excitation of electrons from levels in the forbidden energy band of crystals is discussed in the light of results for CdS crystals. The field excitation of trapped electrons is studied by means of the "electrical glow curve" and the crystal subjected to various annealing treatments between experiments. G. F. J. GARLICK

537.529

10228. Electric breakdown and light emission in CdS single crystals. G. DIEMER. *Philips Res. Rep.*, **9**, 109–21 (*April*, 1954) *In German.*

With measurements on d.c. breakdown in photoconducting CdS single crystals, activated with Cl, *I-V* characteristics are obtained very similar to those of arc discharges in gases. There is a Townsend region, giving rise to anode light, a region of negative slope where light phenomena occur pointing to a positive streamer discharge, and an arc region of thermal character. A.

537.529

10229. On the thickness effect of dielectric breakdown of mica and KCl. I. RYU AND H. KAWAMURA. Note in *J. Phys. Soc. Japan*, **9**, 438–9 (*May–June*, 1954).

Electrical breakdown has been investigated in mica and KCl films $10^{-4}–10^{-3}$ cm and $10^{-3}–10^{-2}$ cm thick respectively. Using pulses the results for mica are consistent with the hypothesis that breakdown is due to a single large electron avalanche, but not in KCl. J. E. CAFFYN

537.529

10230. The statistical time lag of the dielectric breakdown of mica, glass and KCl. H. KAWAMURA, H. OHKURA AND T. KIKUCHI. *J. Phys. Soc. Japan*, **9**, 541–5 (*July–Aug.*, 1954).

The statistical time lag of the dielectric breakdown were measured for mica, glass and KCl, applying the recurrent pulse voltage of $2\times10^{-8}\sim1\times10^{-7}$ sec width. For mica, the statistical time lag was as large as 10^{-4} sec at 10% over-voltage. On the other hand, it was at most less than 10^{-7} sec for glass and KCl at 10% over-voltage. Thus the "single avalanche mechanism" is favoured for mica, since the occurrence of the extremely large avalanche which is responsible for the breakdown may rely on extreme fluctuation, and should be a rare event at the threshold field; while, in the case of KCl as well as glass, the "collective mechanism" is favoured, as is shown by the fact that the statistical time lag is very short. It can be concluded that the avalanche electrons become collective when their density becomes larger than 10^{18}l/cm^3. A.

537.529 : 548.7

10231. On the breakdown of coloured KCl. Y. INUISHI AND T. SUITA. Note in *J. Phys. Soc. Japan*, **9**, 431–2 (*May–June*, 1954).

D.C., a.c. and pulse breakdown voltages have been measured, the d.c. voltage decreases with illumination and is independent of temperature. A.C. and pulse voltages for the coloured and uncoloured are the same and unaffected by illumination. The mechanism of the space charge effects is mentioned. J. E. CAFFYN

X-RAYS 537.531

537.531

10232. A theoretical study of radiation outputs and qualities from a beryllium window tube operated at low kilovoltages (10–50 kVp). I. W. A. JENNINGS. *Brit. J. Radiol.*, **26**, 193–206 (*April*, 1953).

An attempt is made to apply some theoretical data regarding continuous X-ray spectra, due to H. A. Kramer, to the conditions obtaining in the use of low kilovoltage beryllium window tubes. Thus, after introducing the appropriate absorption coefficients, transmitted spectral dose rate distributions are computed for selected absorbers (beryllium, aluminium and air thicknesses). Thence, relative outputs and qualities relating to constant potential generation are derived by graphical integration. These results are then extended to pulsating tension units by applying the data to the actual kV and tube current waveforms

to which the experimental equipment used by the writer is subject. By this means dose rate waveforms are obtained and their relative areas provide the relative outputs under pulsating tension which can be compared with the corresponding experimental data previously published. From a consideration of relative quality data, a correction for the self-hardening effect of the cathode beam target-penetration is made in terms of an equivalent filtration. The dependence of output on tube current, and air absorption losses are also analysed. A.

537.531 : 535.313

10233. Influence of the angle of incidence on the imaging of axial points in a spherical zone-mirror with monochromatic X-rays. F. Asselmeyer. *Z. angew. Phys.*, **6**, 272–5 (*June*, 1954) *In German.*

An investigation of the conditions of imaging by Bragg reflection from crystalline lamellae bent to form spherical surfaces, on the lines suggested by Hoppe and Trurnit [Abstr. 1052 (1949)]. Optical relations are evaluated by geometry for the cases $\theta < 45°$, $\theta = 45°$ and $\theta > 45°$, where θ is the glancing angle (i.e. the complement of the angle of incidence). The focal length is $\pm r/2 \sin\theta$, where r is the radius of the spherical reflecting surface. Expressions are also derived for the range of axial positions of the object point within which the Bragg reflecting condition is satisfied and an image obtained.

V. E. COSSLETT

537.531 : 535.33/.34

10234. *L* absorption and emission spectra of erbium (68) and its energy levels. P. Sakellaridis. *C.R. Acad. Sci.* [*Paris*] **238**, 2296–8 (*June* 14, 1954) *In French.*

See Abstr. 5499 (1953). Further results of a series of measurements on rare earth elements.

J. J. WILKINS

537.531 : 535.33

10235. Secondary excitation of chromium $K\alpha_3$ satellites. H. Herglotz. *S.B. Österr. Akad. Wiss. IIa*, **162**, *No.* 5–7, 235–52 (1953) *In German.*

A comparison is made by photometric and grain counting methods of primarily and secondarily excited $K\alpha_3$ satellites of chromium. The ratio of the intensities (primary to secondary) was $2{\cdot}5 \pm 20\%$ which is in good agreement with the theoretical considerations regarding the origin of the lines and supports the views of Druyvesteyn [*Z. Phys.*, **43**, 711 (1927)]. W. GOOD

537.531 : 535.33

10236. On the structure of the $K\beta$ X-ray spectrum of sulphur. A. Faessler and E. D. Schmid. *Z. Phys.*, **138**, *No.* 1, 71–9 (1954) *In German.*

The emission line from sulphur and various sulphides is found to be broad, whereas the line from some sulphates is sharper. This is discussed in the light of the fact that valence electrons take part in the $K\beta$ transition. A. R. STOKES

537.531 : 535.33.07 : 545.824

10237. An X-ray microanalyzer camera. L. v. Hámos. *K. Tekn. Högsk. Handl.*, *No.* 68, 1–67 (1953).

The technique of X-ray image-spectroscopy developed by the author is based on the property of cylindrically bent crystal surfaces to produce true monochromatic images from layers emitting X-rays. The instrument for producing X-ray image spectra is called an X-ray microanalyser camera. Before describing the actual instrument, the basic theoretical considerations regarding the image formation and the image-intensity as related to the chemical composition of the object are given. In the experimental part tests of the image-forming quality of the camera are described, followed by some typical applications. First, the non-destructive determination of the thickness of surface layers ranging between $0{\cdot}2\,\mu$ and $3\,\mu$ is demonstrated. Second, microanalysis of alloys is described, the volume of the sample involved in the analysis being of the order of 10^{-8} cm^3. Finally, the topographical analysis of surfaces is described as a "chemical mapping" of the concentration of the element corresponding to the X-ray image in question. The method is compared with other X-ray techniques. The list of possible applications includes the combination of the microanalyser camera with self-balancing measuring devices for the rapid evaluation of fluorescence analysis data. A.

537.531 : 535.338

10238. Two types of band emission curves of copper in the soft X-ray region. G. Shinoda, T. Suzuki and S. Kato. Letter in *Phys. Rev.*, **95**, 840–1 (*Aug.* 1, 1954).

$M_{II,III}$ emission curves, presented on a cathode-ray display, were normally of the type obtained by previous workers, but frequently a second type, of the shape required theoretically, was observed for short periods. R. S. PEASE

537.531.08

10239. Dosimetry of very soft X-rays. R. Mock. *Bull. Soc. Franç. Elect.* (*Sér.* 7) **4**, 209–17 (*April*, 1954) *In French.*

A beryllium chamber 5 mm dia., is mounted on the end of a polythene cable and connected in place of the standard chamber to a CGR electrometer. It is calibrated for each quality of radiation used by means of a free air chamber, and is estimated to give an accuracy of $\pm$ 3%. F. T. FARMER

537.531.08 : 537.542

Scintillation spectrometers for measuring the total energy of X-ray photons. *See Abstr.* 10282

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533 : 621.384.6

10240. A pulsed magnetic extractor for removing the electron beam from a betatron. R. S. Foote and B. Petree. *Rev. sci. Instrum.*, **25**, 694–8 (*July*, 1954).

The electron beam of the National Bureau of Standards betatron has been removed by the use of a pulsed magnetic extractor. The electrons were spiralled outward into the extractor that had created a sharp step magnetic field cancelling the betatron guiding field for 19° of azimuth. This step magnetic field was produced by a current pulse flowing in an

array of parallel wires. The removed beam was well focused. Initial testing up to 24 MeV showed that about 60% of the accelerated electrons were extracted in the beam. A.

537.533.3

10241. Theory of electron-optical systems with arbitrarily curved axes. I. I. TSUKKERMAN. *Zh. tekh. Fiz.*, **24**, *No.* 2, 258–73 (1954) *In Russian.*

The general problem has been treated by Cotte (1938), Wendt (1943) and Grinberg (1942–3); Grinberg's method is adopted here, Cotte's being more complicated and Wendt's wrong except when the axis is a plane curve. The paraxial ray equations, a simultaneous pair, involve the radii of curvature and of torsion of the axial ray, as well as the potential functions. The co-ordinates used are the arc length along the axial ray and the displacements along its principal normal and binormal; the arc length is the independent variable of the ray equations. Consideration is confined to stigmatic focusing with magnification independent of orientation, for which conditions are given. Particular cases include focusing in and near the median plane between 2 anti-symmetric magnetic poles, and the astigmatism produced by magnetic scanning coils. The author's solution of the problem of determining the field required to produce a given family of rays in the case of rotational symmetry [Abstr. 6086 (1953)] is extended to the present case. J. C. E. JENNINGS

537.533.3 : 518.5 : 621.385.833

10242. The "mechanical particle," an analog computing machine. B. RANKIN. *Rev. sci. Instrum.*, **25**, 675–8 (*July*, 1954).

A machine is described which solves the equations of motion for a charged particle in a two-dimensional magnetic field. Its accuracy is not limited by the steepness or the asymmetry of the field. Guided by remote control, the mechanism moves continuously over a contour map just as a particle would move through the field itself. The operator matches position, or local field value, with a parameter of the steering control, or curvature of the trajectory. He is able to interpolate continuously between lines of constant field value, thus speeding the process of solution and increasing the accuracy. In five minutes a 40 in. orbit can be drawn over which the field values vary through 23 000 gauss. Five minutes are required for introducing initial conditions, including momentum. For regions in which the field is more than half maximum, the orbits of the mechanical particle and the electromagnetic particle coincide in their radii of curvature to within 0·5%. Accuracy is less for low field values. The performance characteristics have been determined from a working instrument which is fully described. An alternative computer design to the one already in use is also discussed. A.

537.533.3 : 621.385.833

10243. Ultra-high frequency beam analyzer. L. R. BLOOM AND H. M. VONFOERSTER. *Rev. sci. Instrum.*, **25**, 649–53 (*July*, 1954).

This paper describes a method for presenting on a fluorescent screen the time-varying velocity and density modulation of an electron beam, modulated at a frequency of 3000 Mc/s, as it emerges from the cavities of a klystron, the waveguide in a travelling wave tube, or similar structures. In order to deflect an electron beam at this frequency, each pair of the usual deflection plates is replaced by a two-wire transmission line, resonant at the beam modulating frequency. Under proper phase conditions a circular trace is obtained, where one complete revolution of the beam corresponds to one complete cycle of events on the beam at the point of its deflection. Since electrons having different velocities will be deflected differently, a complete velocity and density picture of the beam at a given point of interest is obtained. This is demonstrated by observing the bunching action in the drift region of a velocity modulated electron beam. A.

537.533.331

10244. Multiply symmetric and multiply anti-symmetric [electrostatic] electron-optical systems. A. M. STRASHKEVICH. *Zh. tekh. Fiz.*, **24**, *No.* 2, 274–86 (1954) *In Russian.*

Analytical expressions for the potential are given for a number of cases in which it is independent of z, the axial co-ordinate, as well as the form of the z-dependent solution as a series in the radial co-ordinate. For the z-independent case an iterative method is developed for solving the paraxial ray equations, explicit expressions being given for the coefficients required, as far as the third approximation. The manner of dealing with the z-dependent case is indicated. J. C. E. JENNINGS

537.533.331

10245. Theory of the electrostatic [Einzel] independent lens with thick central electrode. P. EHINGER AND M.-Y. BERNARD. *Cahiers de Phys.*, *No.* 50, 8–16 (*July*, 1954) *In French.*

An extension to an earlier method [Abstr. 6660, 7483 (1954)] is described. Application is made to the calculation of the properties of an Einzel lens with thick central electrode. It is shown that very good agreement is obtained with experimental measurements. M. E. HAINE

537.533.331

10246. The theoretical resolving power of an electrostatic immersion objective. A. SEPTIER. *J. Phys. Radium*, **15**, 573–81 (*July–Aug.–Sept.*, 1954) *In French.*

A geometrical treatment of the aberrations of a simple three-electrode immersion objective is given. Calculations indicate that without a limiting aperture the theoretical resolution limit is about 300 Å. With such an aperture, this limit may be reduced only to about 100 Å, because of the intrinsic spherical aberration of the system. For all practical purposes, the resolution limit lies between these two values.

R. REED

537.533.335

10247. The lower limit of spherical aberration in magnetic electron lenses. W. TRETNER. *Optik*, **11**, *No.* 7, 312–26 (1954) *In German.*

It is shown, by a thoroughly discussed variation method from which the relevant externals are carefully selected, that the spherical aberration constant

C^3 is always greater than or equal to the greater of two quantities involving respectively the parameters H_{max} and $(H'/H)_{max}$. The optimum value of C_3 would lead to a resolving power of ~ 2 Å, but would involve unattainable values of the parameters. It would moreover be undesirable to approach this condition as the focal length would simultaneously tend to infinity.

A. E. I. RESEARCH LABORATORY

537.533.35

10248. The application and limitations of the edge-diffraction test for astigmatism in the electron microscope. M. E. HAINE AND T. MULVEY. *J. sci. Instrum.*, **31**, 326–32 (*Sept.*, 1954).

The ultimate resolving power of the electron microscope lies between 2 and 3 Å. In practice, astigmatism usually sets a higher limit. It is not difficult to correct astigmatism provided a sufficiently sensitive test is available. The paper analyses the edge-diffraction test quantitatively and shows that it can be used to give correction adequate for a resolving power at least as good as 10 Å without resort to photography, and below this with the help of a series of micrographs. The conditions for the successive application of the test method are specified and practical aspects of its use discussed. It is shown that the edge-diffraction fringe can also be used as a test for the adequacy of mechanical and electrical stability, etc. A.

537.533.35 : 539.165

10249. Construction of a magnetic double-lens beta-spectrometer, and the disintegration of Mg^{27}. H. DANIEL AND W. BOTHE. *Z. Naturforsch.*, **9a**, 402–10 (*May*, 1954) *In German.*

The design and construction is described of an iron-free magnetic double-lens β-spectrometer, with water-cooled windings of copper tube and an annular aperture. It has moderate resolving power (1·1% for a point source) and high collecting power (4·6% of 4π); the upper energy limit is 4·3 MeV. The β-spectrum of Mg^{27} (9·5 min) was resolved into two components of $1{\cdot}754 \pm 0{\cdot}011$ MeV (58% intensity) and $1{\cdot}592 \pm 0{\cdot}022$ MeV (42% intensity), and the γ-spectrum into two lines of $0{\cdot}834 \pm 0{\cdot}008$ MeV and $1{\cdot}015 \pm 0{\cdot}007$ MeV. The total disintegration energy came out to $Q = 2{\cdot}59 \pm 0{\cdot}02$ MeV. These figures agree with nuclear reaction measurements and support the disintegration scheme put forward by Koester [Abstr. 6840 (1954)]. The disintegration energy of P^{32} (14·3 day) was measured as $1{\cdot}711 \pm 0{\cdot}006$ MeV. V. E. COSSLETT

537.533.35 : 539.165.08

10250. A β-spectrometer with a magnetic prism and a magnetic lens. V. M. KEL'MAN, N. M. DUSAEV, G. S. MALKIEL' AND N. N. NEVODNICHIĬ. *Zh. éksper. teor. Fiz.*, **26**, *No.* 1, 107–8 (1954) *In Russian.*

Report of realization of an instrument proposed earlier [Abstr. 1053 (1952)]. The prism is a pair of rectangular poles 500 mm × 248 mm of separation 50 mm. The incident beam, from a source at about 1·25 m from the middle of the prism, enters the longer edge almost perpendicularly, and is deflected through 45°; the counter is also at about 1·25 m. The iron-free lens (1350 turns, axial length 5 cm, int. diam. 16 cm, ext. diam. 30 cm) is between source and prism. Circular stops on each side of the prism have diam. 32 mm. In a trial, the source was Th deposit on 8 μ thick Al, 18 mm × 3 mm, turned through $\sim 40°$ to compensate for lens rotation; strength 0·1 mC; counter slit 15 mm × 3 mm. For F line, width at half height is $\Delta(H\rho)/(H\rho) = 0{\cdot}5\%$; max. counts $\text{min}^{-1} = 450$ after subtracting background. J. C. E. JENNINGS

537.533.71

10251. Energy spectra of 35 kV electrons reflected from the surface of solids. W. KLEINN. *Optik*, **11**, *No.* 5, 226–43 (1954) *In German.*

The loss of energy suffered by electrons on being reflected from a plane surface has been studied by means of a velocity analyser using electrostatic lenses. Contamination of the specimen surface was avoided by heating the specimen. The paper is chiefly concerned with discrete energy loss, amounting to several tens of volts. The results are compared with those of previous authors. The agreement is not complete. A. E. I. RESEARCH LABORATORY

537.533.8

10252. Investigation of the distribution of secondary electrons with energy in single crystals of Cu, plated with single crystal layers of Cu_2O. N. B. GORNYĬ. *Zh. éksper. teor. Fiz.*, **26**, *No.* 3, 327–36 (1954) *In Russian.*

Experimental results are obtained by the method of retarding electric field, the secondary current from the the collector displacing the position of the distribution curve maximum to the side of smaller energy. Single-crystal (100)/(110)/(111) and polycrystalline specimens were examined and the curves are shown. While a smooth curve with a single maximum is obtained with the latter specimens, there is some evidence of secondary maxima with the former, at 450°C, but experimental scatter makes this less than certain. The apparatus is described in detail. W. BARDSLEY

537.533.8

10253. The radio-frequency fine structure of the photon beam from the Berkeley synchrotron. R. MADEY, K. C. BANDTEL AND W. J. FRANK. *Rev. sci. Instrum.*, **25**, 537–40 (*June*, 1954).

The full energy spread-out bremsstrahlung beam of the Berkeley synchrotron was shown to be emitted in sharp bursts with the 47·7 Mc/s frequency of the electrons in the doughnut. A two-counter telescope, located about 20 in. away from a $\frac{1}{4}$ in. thick lead target and about 20° from the photon beam direction, was used to measure an accidental coincidence counting rate as a function of the length of delay line in one input to the coincidence circuit. When the length of delay cable was chosen equal to integral multiples of the period of the radio-frequency oscillator, the coincidence counting rate was of the order of 100 counts per unit of integrated beam; on the other hand, when the length of delay line was chosen to be equal to one-half of odd integral multiples of the period of the radio-frequency oscillator, the coincidence counting rate was less than about two counts per unit of integrated beam. An estimate of the width of a single pulse of photons can be obtained from the measurement by unfolding a Gaussian resolution function of the coincidence circuit. If the time variation of the intensity of the photon beam is assumed to be a

Gaussian function, then the r.m.s. value of that Gaussian is found to be less than $1{\cdot}5\times10^{-9}$ second. A calculation indicates that the measured radio-frequency fine structure should provide a rather accurate picture of the phase-stable bunch of electrons at the end of the acceleration period. A.

537.533.8

10254. Angle-energy distribution of radiation from high-energy electron accelerators. R. M. Warner, Jr and E. F. Shrader. *Rev. sci. Instrum.*, **25**, 663–7 (*July*, 1954).

An energy-analysing detector of the pair-spectrometer type has been used to observe the angular distribution of bremsstrahlung produced by 17 MeV monokinetic electrons in molybdenum betatron targets. Distributions were measured for γ-ray energies of 7, 11 and 15 MeV, for each of three targets whose thicknesses were approximately 2, 5 and 21 mils. Reproducible variations of spectrum with angle were found, the variations becoming more pronounced with increasing target thickness. The experimental distributions are compared here with the theoretical distributions of Schiff and Lawson, the former being significantly narrower. Axial relative spectra are also presented. A.

537.533.8

10255. State of polarization of bremsstrahlung. C. Tzara. *C.R. Acad. Sci.* [*Paris*] **44**–7 (*July* 5, 1954) *In French.*

Experimental evidence is given for the existence of a polarization of the bremstrahlung photons from 22 MeV electrons. P. ROTHWELL

537.533.8 : 539.153

10256. Part played by electrons of the lower energy bands in the secondary electron emission of metals. A. Ya. Vyat-skin. *Zh. éksper. teor. Fiz.*, **24**, *No.* 4, 429–34 (1953) *In Russian.*

See also Abstr. 8791 (1950). Discusses the interaction between a primary electron endowed with a sufficient velocity and a *K*-level electron of Li, the *K* level being assumed to be the discrete level of a free Li atom. It is shown that, for Li, the part played in the total emission by the *K*-electrons is small compared with the contribution of lattice electrons. F. LACHMAN

537.533.8 : 539.234

10257. A comment on the behaviour of freshly evaporated metal films. H. Gobrecht. *Z. Phys.*, **138**, *No.* 3–4, 345–52 (1954) *In German.*

For background see Abstr. 7334 (1952). Counter measurements of the emission from fresh metal surfaces as a function of time, speed of evaporation and thickness resulted in the expression $I = At^{-\alpha}$; α is proportional to film thickness for equal evaporation speeds and to evaporation speed for equal thicknesses. A. H. W. BECK

537.533.9

10258. Film dosimetry of electrons in the energy range 0·5–1·4 MeV. J. Fleeman and F. S. Frantz, Jr. *Amer. J. Roentgenol.*, **71**, 1049–55 (*June*, 1954).

The responses of Minimax Dental X-ray film and du Pont Dosimeter film type 552 as monitors were measured for monoenergetic electron beams in this range, and also for β-rays from U^{238}. Films were wrapped in 7 mg/cm^2 polystyrene to simulate the dead skin layer, and the energy dissipated in this layer was measured by film blackening and by ionization (extrapolation chamber described). Density-dosage relationship was determined in steps of 0·1 MeV (graphs given) and found to be independent of energy from 0·5–1·4 MeV. The slope of the response curve for U^{238} is less than that for the monoenergetic beams, showing that knowledge of the spread of the energy spectrum (as provided by a step wedge) is also necessary for monitoring electrons. D. MABBS

537.533.9

10259. Quantum effects in the interaction between electrons and high-frequency fields. I. I. R. Senitzky. *Phys. Rev.*, **95**, 904–11 (*Aug.* 15, 1954).

The passage of an electron through a cavity resonator is considered for the purpose of studying the appearance of quantum mechanical effects in an essentially classical experiment as the frequency of the electromagnetic field becomes high. Both the electron and the field must be represented, initially, by wave packets—in space and momentum co-ordinates for the former, and in electric field and vector potential co-ordinates for the latter—in order to correspond to classically meaningful systems. The velocity of the electron at the output of the cavity is investigated. It is found that the expectation value of velocity has a quantum-mechanical correction term. A more significant effect, however, is the non-vanishing of the expectation value of the square of the deviation from the expectation value (mean square deviation from the mean) of the velocity. This deviation is a random phenomenon which will produce noise in an electron beam. An expression for the mean square deviation, in which the results of electron and field quantization are separately apparent, is derived, and its significance is discussed. An order-of-magnitude calculation is made for the ratio of minimum possible mean square deviation of velocity to velocity increment due to the field, and the frequency for which this ratio becomes unity is calculated for a particular set of conditions to be of the order of 3×10^{12}/sec. A.

537.534 : 537.591

The acceleration of charged particles moving in a magnetized medium. *See Abstr.* 10300

537.534 : 621.384.6

10260. Elementary theory of accelerators. II–III. Č. Šimáně. *Elektrotech. Obzor.*, **42**, *No.* 10, 550–7; *No.* 12, 676–85 (1953) *In Czech.*

For Pt I, see Abstr. 4146 (1953). Part II treats the general theory of circular accelerators and the special theory of the betatron. Part III deals with the theory of h.f. circular accelerators. A.

537.534 : 621.384.61

10261. The University of Washington sixty-inch cyclotron. F. H. Schmidt, G. W. Farwell, J. E. Henderson, T. J. Morgan and J. F. Streib. *Rev. sci. Instrum.*, **25**, 499–510 (*May*, 1954).

The new constant frequency 60 in. cyclotron at the University of Washington is described. Its principle mechanical features are the following: (1) A 20 in.

diffusion pump is placed close to the vacuum chamber in order to provide high pumping speed. (2) The r.f. conductors are almost free of unsoldered joints in order to provide a high-Q circuit. (3) The positions of the shorting "spiders" can be readily changed without breaking the vacuum. (4) The dees and dee stems are removable as one unit from the vacuum envelope. (5) The cyclotron vacuum chamber is constructed of welded aluminium alloy in order to reduce accumulated radioactivity. (6) A unique side-loading target chamber can be used for ordinary bombardments without disturbing apparatus more remote from the cyclotron. (7) The exit strip and other parts of the dee system subject to beam erosion are made of graphite. The oscillator uses a single ML-5681 tube in a grounded-grid self-excited circuit. A 2 kW frequency-modulated booster oscillator drives the main oscillator above the "multipactoring" threshold. A cathode bias resistor is used in place of the familiar constant-current network. Ions are drawn out of the dees by means of a d.c.-biased r.f. deflector. Four degrees of freedom of the deflector are adjustable from the console. An account is given of the major troubles encountered and the steps taken to achieve satisfactory operation. The cyclotron produces external beams of 125 to 200 μA at a nominal deuteron energy of 21 MeV with an oscillator power input of 100–125 kW. A.

537.534 : 621.384.61

10262. Regenerative deflection as a parametrically excited resonance phenomenon. S. E. Barden. *Rev. sci. Instrum.*, **25**, 587–93 (*June*, 1954).

The phenomenon termed regenerative deflection [Abstr. 2754 (1952)] is treated as a resonance mechanism forming only one of a larger class of similar mechanisms. Conditions of optimum coupling to promote the growth of radial oscillations are described, and the results of some numerical calculations are given. The causes of the axial spreading of the beam during the extraction period are analysed, and methods of reducing such spreading are discussed. An electrodynamic system for creating the coupling inhomogeneities is also described. A.

537.534.3 : 621.384.6

10263. Alternating gradient focusing of cyclotron external beam. E. L. Hubbard and E. L. Kelly. *Rev. sci. Instrum.*, **25**, 737–9 (*Aug.*, 1954).

The ¾ MeV external proton beam from the 20 in. cyclotron appeared to diverge horizontally from one point and vertically from another point. With a series of three alternately converging and diverging electrostatic lens elements of hyperbolic cross-section, it was possible either to focus the external beam to a point or to make it parallel. A.

537.534.3

10264. Current carrying deflector-plates for rotating a beam of charged particles. P. A. Einstein and A. G. Edwards. *J. sci. Instrum.*, **31**, 222–3 (*June*, 1954).

A method is described for rotating a flat beam of charged particles about an axis in the direction of travel. The beam is passed between two resistive plates arranged parallel to it. A current is passed through the plates in a direction perpendicular to the direction of motion of the beam, and parallel to its flat side. The current in opposite plates is opposed. The electrostatic field resulting from the potential drop across the plates results in the rotation or twisting of the beam. Application to slit alignment in mass spectrometers is suggested. M. E. Haine

537.534.3 : 533.59

10265. A mass spectrometer for leak detection. C. Cassignol, R. Geller and J. Moreau. *Vide*, **8**, 1415–21 (*Nov.*, 1953) *In French.*

A brief description, with photographs, of a mass spectrometer leak-detector with a double monochromator and a novel high efficiency ion-source, giving a high signal-noise ratio. The monochromator uses the construction due to L. Cartan [*J. Phys. Radium*, **8**, 447 (1937)]. No figures are given for the performance. A. H. W. Beck

537.534.3 : 621.384.8 : 621.389

10266. A high-resolution mass spectrometer with variable-bandwidth measuring circuits. I. Pelchowitch. *Philips Res. Rep.*, **9**, 2–41 (*Feb.*, 1954).

A high-resolution mass spectrometer of the magnetic-sector type is described. Detailed analysis and circuitry of the electronic portion are given. This is planned so as to include the possibility of varying the time of observation whilst retaining a high sensitivity in the measuring circuits. Accordingly the component units are designed for static and for dynamic operation. The ion-accelerating voltage supply can give a voltage sweep variable in starting-voltage value, amplitude and time dependence. It is also constructed to have a low effective impedance to minimize the disturbing effects of induction and leakage currents. A special d.c.-coupled wide-band electrometer amplifier covering the range 0–1000 c/s is described. The useful bandwidth can then be selected by the succeeding measuring units in order to have a high s/n. ratio. The circuits of an oscillograph display of the ion currents are given. An added feature of the instrument is an improved space-charge emission regulator used in connection with a modified Nier-type ion source. A.

537.534.74

10267. Contribution to the study of α-particle-proton scattering for α-particles of 3·1–5·3 MeV energy. C. Ruhla. *J. Phys. Radium*, **15**, 451–9 (*June*, 1954) *In French.*

A thin film ($\sim$6 mg.cm^{-2}) of cellophane was bombarded with Po α-particles and the ejected protons studied by means of nuclear emulsions. The results indicate that there are no resonances for $3{\cdot}1 < E_\alpha < 5{\cdot}3$ MeV; the scattering obtained cannot be entirely explained on the basis of Coulomb forces. A. O. Stanesby

537.534.74

10268. Scattering of 96 MeV protons from light nuclei. K. Strauch and W. F. Titus. Letter in *Phys. Rev.*, **95**, 854–5 (*Aug.* 1, 1954).

Graphs are given of the energy distribution of the protons scattered from carbon and sulphur targets at 40° in the lab. system. Peaks on the continuum are interpreted as due to excitation of known low energy levels in the nuclei C^{12} and S^{32}. J. Hughes

537.534.74

10269. Scattering of 314-MeV polarized protons by deuterium. J. MARSHALL, L. MARSHALL, D. NAGLE AND W. SKOLNIK. *Phys. Rev.*, **95**, 1020–5 (*Aug.* 15, 1954).

The polarization of deuterium for 314 MeV protons has been examined as a function of angle. A beam of 314 MeV protons about 60% polarized was scattered by a liquid deuterium target. Measurements were made of the asymmetry of scattering of fast protons, namely both elastically and inelastically scattered, as a function of angle. The polarization of protons by deuterons, inferred from the asymmetry, was found to be small at small angles, to be about 0·35 from 10° to 30° laboratory angle, to be zero at 45° and negative thereafter. The polarization of quasi-free proton-proton scattering measured with the two scattered protons in coincidence, was found to be zero at 41° and 49° laboratory angle within statistical error. The polarization of quasi-free proton-neutron scattering was computed from measurements with the scattered proton and neutron in coincidence and was found to be $0{\cdot}56 \pm 0{\cdot}12$ at 29° laboratory angle. The polarization of elastic scattered protons was computed from measurements using absorbers chosen to discriminate between elastic and inelastic protons, giving $0{\cdot}59 \pm 0{\cdot}07$ at 24°, $0{\cdot}29 \pm 0{\cdot}05$ at 28°, $0{\cdot}39 \pm 0{\cdot}18$ at 32° and $-0{\cdot}05 \pm 0{\cdot}16$ at $35° \pm 4°$ laboratory angle. The polarization of protons by deuterium appears to vary with angle in approximately the same way as the proton polarization of H. One can say tentatively that the polarization of protons by neutrons at this energy has the same sign and about the same magnitude. The differential cross-section of deuterium for scattering of protons is given as a function of barycentric angle of the $p - d$ system from 10 to 80 degrees.

A.

537.534.74

10270. Scattering of ions by polarization forces. E. VOGT AND G. H. WANNIER. *Phys. Rev.*, **95**, 1190–8 (*Sept.* 1, 1954).

The interaction potential of a charge carrier and a gaseous atom is attractive at large distances, varying as r^{-4}. This potential has simple classical properties since it has a cross-section which varies inversely as the speed. For most ions the mechanism which removes the singularity of the potential is irrelevant classically—this is also the case in quantum theory: the well-known indeterminacy of the wave-function for singular potentials can be removed in an obvious way and a cross-section of the capture type can be computed. This cross-section oscillates sinusoidally about its classical value but has apparently no average deviation over one cycle, even when the de Broglie wavelength is long. In the limit of low velocities, the quantum-mechanical cross-section has twice the classical value. These two facts combine to make the classical law of variation of the cross-section approximately valid even in the quantum range. A.

537.534.74

10271. Scattering of protons by hydrogen near 18 MeV. J. L. YNTEMA AND M. G. WHITE. *Phys. Rev.*, **95**, 1226–35 (*Sept.* 1, 1954).

The differential cross-section for the scattering of $18{\cdot}2 \pm 0{\cdot}2$ MeV protons by hydrogen has been measured over the angular range 30°–90° in the centre-of-mass system. In order to reduce the over-all errors to less than 1% a 60 in. scattering chamber was used. Polyethylene, polystyrene and nylon foils were used as scatterers while the proton-proton events were detected by observing coincidences between the scattered and recoil protons in anthracene photomultiplier counters. The incident proton beam was collimated to ± 14 minutes of arc. Probable relative errors varied from 0·5% at 90° to about 1% at 30°, while the probable error in the absolute differential cross-section at 90° is estimated to be 1%. The data show a significant deviation from pure S-wave scattering and are best fitted by taking S-, P- and D-wave phase shifts to be $k_0 = 54{\cdot}1°$, $k_1 = +1{\cdot}0°$, $k_2 = +0{\cdot}4°$, respectively. A.

537.534.75

10272. Energy loss in matter by fast particles of low charge. J. LINDHARD AND M. SCHARFF. *K. Danske Vidensk. Selsk., mat-fys. Medd.*, **27**, *No.* 15, 30 *pp.* (1953).

The average specific energy loss of particles of velocity v and charge ze passing through a substance of atomic number Z of density N atoms per unit volume has been given by Bethe as:

$$dE/dR = (4\pi z^2 e^4/mv^2) \,.\, NZ \log (2mv^2/I)$$

where I is the average excitation potential of the substance. Bloch has shown that $I \simeq I_0 Z$, where I_0 is a constant for all substances, but an accurate calculation of I_0 was not possible from his model. The agreement of Bethe's formula with experimental results is not good when the velocity of the particles becomes comparable with that of the more strongly bound electrons of the substance. This paper describes the atom mainly in terms of the Thomas–Fermi model, and by giving a more detailed mathematical treatment produces a more general expression for the dependence of dE/dR on v, which is in close agreement with experimental results. The value for the constant I_0 is determined in terms of the Thomas–Fermi, Lenz–Jenson and Hartree models, and straggling is also discussed mathematically.

D. R. CHICK

537.534.75

10273. Electron capture and loss by heavy ions penetrating through matter. N. BOHR AND J. LINDHARD. *K. Danske Vidensk. Selsk., mat-fys. Medd.*, **28**, *No.* 7, 29 *pp.* (1954).

A comprehensive interpretation of the phenomena associated with the passage through matter of highly charged ions (with special reference to fission fragments) is given on the basis of simple arguments. The discussion is under the following headings: General features of the balance between capture and loss by heavy ions; Approximate description of ion constitution; Mechanism of electron loss and capture; Discussion of experimental evidence on capture and loss by fission ions in gases at low pressures; Dependence of average ion charge on density of material.

J. HUGHES

537.534.75

10274. Bohr's theory of energy losses of moving charged particles. J. NEUFELD. *Phys. Rev.*, **95**, 1128–33 (*Sept.* 1, 1954).

The stopping power of a particle having charge $Z_{\text{eff}}\varepsilon$ and moving with velocity v has been determined by Bohr for $\kappa = 2Z_{\text{eff}}\varepsilon^2/\hbar v$ and $\eta_s = 2v/u_s > 2$, where u_s is the velocity of the orbital electron that is effective in stopping the particle. Bohr's results are formulated differently for $\kappa/\eta_s < 1$ and $\kappa/\eta_s > 1$ and are based on an orbital picture of the processes involved. An alternative method has been developed in which the space surrounding the particle track has been subdivided into three regions: (*a*) the region of validity of the Rutherford formula (adjacent to the track), (*b*) the intermediate region involving large perturbations for which no adequate theory exists at the present time, and (*c*) the region of validity of the quantum perturbation theory (the most remote from the track). By extrapolating the formulae valid in regions (*a*) and (*c*) into the region (*b*), the contribution to the stopping power due to the region (*b*) has been estimated, and adding to it the contribution due the regions (*a*) and (*c*) an expression has been derived from the total stopping power that is applicable whenever $\kappa > 1$ and $\eta_s > 1$. This expression has a wider region of applicability than the corresponding Bohr's formula since the latter can be used only for $\kappa \ll \eta_s^3$ if $\kappa/\eta_s > 1$. The physical picture used for deriving this expression is somewhat similar to the one used by Bohr for $\kappa/\eta_s < 1$ but is different from the one used by Bohr for $\kappa/\eta_s > 1$. A.

DISCHARGE TUBES . COUNTERS 537.54

537.541

10275. High-intensity ion source for cyclotrons. R. S. LIVINGSTON AND R. J. JONES. *Rev. sci. Instrum.*, **25**, 552–7 (*June*, 1954).

The mechanical design features and operating characteristics of a hot-cathode arc-discharge type ion source are described. Proton currents of 500 mA have been obtained under d.c. test conditions. A maximum current of 3 mA of 22 MeV protons has been obtained with the source installed in the ORNL 86 in. cyclotron. Distinguishing features of the ion source are its arc chamber of carbon, its heavy tantalum filament heated with d.c. and its use of a specially shaped accelerating electrode. A.

537.542

10276. On the efficiency of quanta detection in proportional counters. A. BISI AND L. ZAPPA. *Nuovo Cimento*, **12**, 211–16 (*Aug.*, 1954).

For the determination of the efficiency of quanta detection, integrals have been deduced and tabulated for some special geometrical arrangements; an experimental investigation of the wall effect in argon has been carried out for quanta of energies up to 50 keV. A.

537.542

10277. External cathode Geiger–Muller counters of small diameter. D. BLANC. Letter in *J. Phys. Radium*, **15**, 590–1 (*July–Aug.–Sept.*, 1954) *In French.*

Following the accepted technique for constructing external-cathode counters a series was made with internal diameter 5 mm. As a typical case one of these, 4 cm long, has a plateau 800 V long, with a slope of 5% per 100 V. The useful counting life is not stated. L. E. MUSSELL

537.542

10278. A contribution to the theory of ionization chamber measurements at low pressures. J. R. GREENING. *Brit. J. Radiol.*, **27**, 163–70 (*March*, 1954).

The ionization chamber measurements of other workers at low pressures have indicated (i) that the measured current is in excess of that to be expected on the Bragg–Gray theory; (ii) that there is a residual current even at sensibly zero pressure; (iii) that the gradient of the ionization-pressure curve at low pressures is less than that at atmospheric pressure, and (iv) that the saturation curves of chambers at low pressures are often grossly asymmetrical. Effects (i) and (ii) are attributed to the deflection by the chamber voltage of slow electrons emitted from the chamber walls. Expressions are derived for the number of electrons deflected between plane, spherical and cylindrical electrodes. The numbers of electrons emitted per cm² per r deduced from ionization chamber measurements are found to agree, within a factor of 2, with the corresponding numbers derived indirectly from other data, and are approximately 5×10^5 per cm² per r and 1×10^6 per cm² per r for graphite and elektron metal respectively irradiated by radium γ-rays. The approximate energy distribution of these slow electrons is indicated. Effect (iii) is attributed to the difficulty of achieving saturation without producing ionization by collision. At low chamber volts some ions have sufficient energy to reach the electrode of the same polarity. Effect (iv) is attributed to differences in electrode areas and the asymmetry of the electric field between the electrodes. An example of a calculated saturation curve is given for spherical electrodes. Finally it is suggested that similar effects would occur at atmospheric pressure in chambers having extremely small electrode separations. A.

537.542 : 621.387.422

10279. Effect of chamber voltage on electron build-up measurements. J. E. RICHARDSON. *Radiology*, **62**, 584–8 (*April*, 1954).

Using a parallel-plate type ionization chamber of small depth for electron build-up measurements the polarity of the voltage causes substantial differences in the observed currents. This is due to electron build-up in the current-collecting section of the chamber. The true ionization within the active volume of the chamber is given by the average of the two readings obtained by reversing the voltage.

H. MILLER

537.542 : 537.531.08 : 621.317.31

10280. A review of the theory, calibration techniques, and applications of an ionization current comparator, with an investigation of its capabilities as a precision instrument. L. A. W. KEMP. *Amer. J. Roentgenol.*, **71**, 853–63 (*May*, 1954).

A more detailed theory is presented of the ioniza-

tion current comparator described earlier by Kemp (1946). Calibration procedures by the theoretical method and by a precision experimental method are compared, and it is shown that the comparator is capable of very high precision measurements. Some applications especially using free air chambers are discussed. H. MILLER

537.542 : 539.164 : 548.7

Conductivity of CdS crystals excited by α-rays. *See Abstr.* 9750

537.542

10281. Radiation dosimetry with scintillation detectors. E. H. BELCHER. *Brit. J. Radiol.*, **26**, 455–63 (*Sept.*, 1953).

The theoretical considerations influencing the design of scintillation dosemeters are discussed. Details are given of simple and robust probe-type scintillation dosemeters suitable for clinical application. These instruments permit the measurement of dosage-rates due to X- or γ-radiation of 0·5 r per hour and upwards, with a probe having an outside diameter no greater than $\frac{1}{4}$ in. Experimental data are presented concerning the sensitivity, stability, energy-dependence, temperature-dependence and directional properties of dosemeters of this type incorporating various crystalline luminophors. A.

537.542 : 537.531.08

10282. Scintillation spectrometers for measuring the total energy of X-ray photons. R. S. FOOTE AND H. W. KOCH. *Rev. sci. Instrum.*, **25**, 746–58 (*Aug.*, 1954).

X-ray spectrometers are described that operate on the principle of totally absorbing the energy of an individual X-ray photon in a scintillator. Experiments with scintillators of xylene containing terphenyl, and of sodium iodide activated by thallium, show that detection efficiencies better than 80% and energy resolutions better than 10% are attainable in the X-ray energy range from $\frac{1}{2}$ to 50 MeV. Monte Carlo calculations and crude scaling laws that simplify extrapolations to other size scintillators are discussed. A.

537.542 : 539.16.08

10283. Liquid scintillation counting of tritium and C^{14} labeled compounds. D. J. ROSENTHAL AND H. O. ANGER. *Rev. sci. Instrum.*, **25**, 670–4 (*July*, 1954).

A liquid scintillation counter suitable for measuring H^3 and C^{14} activities is described. A photomultiplier tube with a high sensitivity and signal-to-noise ratio is used, and is cooled to −10°C to further reduce the tube noise background. The phototube is mounted in a chassis containing its preamplifier, and the pulses are then led to a high-stability amplifier scaler. The radioactive materials are dissolved in aliquots of a xylene solution containing *p*-terphenyl (1·9 g/litre) and diphenylhexatriene (0·020 g/litre). Substances which quench the scintillations or colour the scintillator solution cannot be counted by this method. A minimum of $4{\cdot}3\times10^{-10}$ curie of H^3, or $1{\cdot}8\times10^{-11}$ curie of C^{14} may be measured by the counter. A.

537.542 : 539.166.08

A scintillation γ-ray spectrometer. *See Abstr.* 10464–5

537.542 : 621.374.32

10284. A flexible single-channel pulse-amplitude analyser. F. J. M. FARLEY. *J. sci. Instrum.*, **31**, 241–5 (*July*, 1954).

This instrument is designed for measuring the amplitude of voltage pulses with particular application in nuclear counting. An output pulse is obtained only when the input pulse has an amplitude lying between two preset limits; the lower limit being variable from 5 to 50 V, and the interval between the limits being 0·5, 1, 2, 3, 5 or 7·5 V, selected by a switch. The instrument can also be used as a simple discriminator. A feature of this instrument is that without readjustment it can deal with a wide variety of input pulses, from 0·2 μsec to over 1000 μsec in length. In all cases the dead time is only 0·1–0·5 μsec. The design which is unusually simple, includes a high-speed threshold amplifier, an improved high-speed discriminator circuit and a new veto circuit. A.

537.542 : 519.24

10285. Statistical purity in nuclear counting. O. RIEDEL. *Nucleonics*, **12**, 64–7 (*June*, 1954).

The analysis of sets of counts, to determine if the statistics are due to randomness of the radioactive processes or depend upon defects in counting equipment, is discussed. The use of Probability Integral Graph Paper is outlined. In this the integral along the Gauss curve appears as a straight line on which experimental observations of numbers of counts against frequency should fall if the statistics are pure. L. R. SHEPHERD

537.542 : 537.531

10286. Collimated X-ray beam for study of distortion in cloud chambers. R. S. CARTER AND J. C. STREET. *Rev. sci. Instrum.*, **25**, 627–31 (*July*, 1954).

A narrow, well-collimated beam of soft X-rays has been used for the purpose of measuring distortion in cloud chambers. The path of the X-ray beam in the cloud chamber is made visible by the ionization of the short-range photoelectrons. The main advantage of this method is that it can be used in the presence of a magnetic field. A limitation of the method is the finite width of the track. In argon it was not difficult to get a track 0·06 cm wide, allowing measurement to 0·004 cm. The appearance of the beam in both a diffusion and an expansion chamber is described. In addition to its use in measuring distortion, its applications to measuring rates of droplet growth and length of cloud-chamber sensitive times are discussed. A.

IONIZATION . THERMIONICS 537.56/.58

537.56

10287. Ultraviolet photons in the decay of metastable argon atoms. L. COLLI. *Phys. Rev.*, **95**, 892–4 (*Aug.* 15, 1954).

Some measurements of the lifetime of u.v. photons emitted by the excited states of argon are reported, when the excitation is obtained by the impact of the electrons in a Townsend avalanche. The measurements were made by converting the ultraviolet into

visible light by means of a fluorescent screen and by observing the visible light with a photomultiplier. The results are that the energy of the u.v. photons is about 10 eV and that the law of emission in time is represented by the formula $\exp - t/\tau_A - \exp - t/\tau_M$, where $\tau_A = 3{\cdot}4 \times 10^{-6}$ sec and $\tau_M = 1/9p^2$ sec (p = gas pressure in mm Hg). A.

537.561

10288. On the theory of the excitation spectra of a system of multi-particles. V. P. Silin. *Zh. éksper. teor. Fiz.*, **23**, *No.* 6 (12), 641–8 (1952) *In Russian.*

The spectra of systems of multi-particles with central interaction are considered at high temperatures (Boltzmann distribution), as well as at low temperatures (Fermi distribution). In the region of long wavelengths the excitations correspond to those obtained in the investigation of the classical kinetic equation with self-consistent interaction. In the region of short wavelengths the quantum character of the excitations becomes essential. Transverse vibrations were considered in a system of electrons placed in a medium with a dielectric constant.

E. RABKIN

537.561

10289. On the excitation spectrum of a system of electrons and ions. V. P. Silin. *Zh. éksper. teor. Fiz.*, **23**, *No.* 6 (12), 649–59 (1952) *In Russian.*

In the short-wave region the electrons and ions are excited independently of each other. Long-wave excitation can be represented by two branches of vibrations: one has a finite maximum frequency and the other corresponds to sonic vibrations. At low temperatures the sonic vibrations are weakly attenuated, but at high temperatures, by contrast, the attenuation is comparatively strong, and they are propagated only over distances comparable to the wavelength. E. RABKIN

537.564

10290. The effect of contaminating gases on the energy per ion pair [W] in helium. G. A. Erskine. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, 640–2 (*July*, 1954).

Theoretical calculations of W in He containing A, Kr or Xe are made for two cases: (1) assuming that each metastable He atom, and (2) assuming every excited He atom, leads to the production of an ion pair by collision with an impurity atom. Assumption (2) gives results in better agreement with the values of W measured experimentally by Jesse and Sadauskis [Abstr. 291 (1953)]. J. DUTTON

537.564 : 539.153

10291. Ionizing collisions of very fast particles and the dipole strength of optical transitions. U. Fano. *Phys. Rev.*, **95**, 1198–200 (*Sept.* 1, 1954).

Discusses how the Bethe theory of ionizing collisions should be adapted to gases other than atomic hydrogen. Experimental data on primary ionization, analysed by the method of McClure, yield the value of the total dipole strength for ionization, $\int_I^\infty |x_W|^2 dW$, an atomic property which is otherwise poorly known and whose relationship to the diamagnetic susceptibility should be of interest. A.

537.565

10292. On the mobility of ions in air. E. Montel and T.-T. Ouang. Letter in *J. Phys. Radium*, **15**, 586–7 (*July–Aug.–Sept.*, 1954) *In French.*

See Abstr. 6288 (1951). A series of measurements have been made on the ions produced by α-rays from polonium. No special precautions were taken about the humidity of the air. For the negative and positive ions respectively the mobilities are found to be 1·61 and 1·25 cm/sec per volt/cm. J. S. BELL

537.566 : 538.12

10293. Magnetic fields in turbulent streaming plasmas. P. O. Schilling and W. Lochte-Holtgreven. *Z. Naturforsch.*, **9a**, 520–6 (*June*, 1954) *In German.*

Describes an experimental arrangement, consisting essentially of an interrupted spinning flame (burning propane), which demonstrates by means of induced voltages in an external pick-up coil (surrounding the flame chamber) that magnetic fields are produced in the flame plasma. A high degree of ionization in the latter is ensured by injecting potassium. The magnetic field is to be attributed to the separation of electrons and positive ions. J. D. CRAGGS

537.581

10294. Thermionic constants of metals and semiconductors. IV. Monovalent metals (continued). S. C. Jain and K. S. Krishnan. *Proc. Roy. Soc. A*, **225**, 159–72 (*Aug.* 31, 1954).

For Pt III, see Abstr. 6905 (1953). In a monovalent metal, in which the valency electrons may be regarded as forming a free-electron assemblage, the assumption of a temperature-independent energy barrier at the surface of the metal is shown to be equivalent to taking the free electrons in the condensed phase, namely, the metal, and the electrons in the gaseous phase in thermal equilibrium with it, as forming a homogeneous single component system. The temperature variation of the work function is then determined by the temperature variation of the thermodynamic potential of the electrons in the condensed phase, when the external pressure is kept constant at the value of the saturation vapour pressure of the electrons, which is equivalent to keeping the pressure of the electron assemblage in the condensed phase also constant, since the energy barrier at the surface is independent of temperature. It is further shown that for a degenerate, or nearly degenerate, electron assemblage the specific heat at constant pressure is the same as that at constant volume, and it is easily calculated. The temperature coefficient of the work function calculated therefrom corresponds to an apparent lowering of about 8 to 10% in the value of the A coefficient in thermionic emission. This agrees with observation. On the other hand, the thermal expansion of the lattice is found to be about 25 to 50 times that to be expected thermodynamically for the electron assemblage in the condensed phase. This result, when viewed against the nearly normal observed value of the A coefficient, shows that the energy barrier at the surface of the metal should decrease with increase of temperature by the same amount by which the thermodynamic potential of the electrons in the condensed phase decreases as a result of the thermal expansion of the

lattice. A detailed calculation is made of the effect of both the thermal expansion of the lattice, and the increased thermal oscillations of the atoms in the lattice, associated with the rise in temperature, on the energy of the barrier at the surface. The net effect is found to be a lowering of this energy of the required magnitude. A.

537.583 : 537.533.1 : 621.385.032.216

10295. The velocity distribution of electrons of thermionic emitters under pulsed operation. II. Experimental results and a tentative theoretical explanation. C. G. J. Jansen, R. Loosjes and K. Compaan. *Philips Res. Rep.*, **9**, 241–58 (*Aug.*, 1954).

The velocity distribution among electrons emitted by metallic and oxide-coated cathodes is investigated by means of the apparatus described in Pt I [Abstr. 4890 (1953)]. Both under square-pulsed and d.c. loads metallic cathodes emit electrons with a single well-defined velocity, the dispersion in velocity lying below the resolving power of the observational technique. (BaSr)O and SrO coatings, on the other hand, show under square-pulsed conditions a large dispersion in electron velocities up to several hundreds of volts with spectra consisting of a set of more or less discrete lines. Under a d.c. load the same oxide coatings emit electrons with nearly uniform velocities, the spectrum consisting of one rather sharp line. When d.c. is applied to a square-pulsed load the line spectrum gradually contracts into a single line as the proportion of d.c. is increased. Coatings of BaO, ThO_2, and of a mixture of (BaSr)O and nickel powder give a one-line spectrum, although this line is less sharp than with metallic cathodes. The velocity spectra of (BaSr)O and SrO are attributed to a high resistance in the surface layer of the coating which arises owing to the combined effect of the conduction through the solid material and through the pores. The occurrence of discrete lines is tentatively attributed to the combined effect of the potential distribution in the surface layer, of secondary emission, and of the geometry of the pores. The effect of a d.c. load is ascribed to polarization in the oxide layer. A.

537.583 : 621.385.032.216

10296. Mechanism of the falling-off of thermionic emission of an oxide cathode operating in impulse conditions. K. B. Tolpygo. *Zh. éksper. teor. Fiz.*, **24**, *No.* 4, 478–85 (1953) *In Russian.*

Discusses in detail the hypothesis of Pokrovskiĭ [Abstr. 7045 (1951)], assuming the existence, between the core and semiconductor of an oxide cathode, of a barrier layer capable of inhibiting the thermo-emission current. It is shown that, for the customary relatively thick oxide films (thickness of an order of magnitude exceeding 10^{-5}–10^{-4} cm, which is the order of magnitude of the screening radius), the proposed inhibition mechanism leads to results contradicting the experimental data. F. LACHMAN

537.583 : 621.385.032.216

10297. Remarks on the paper by K. B. Tolpygo "Mechanism of the falling-off of thermionic emission of an oxide cathode operating in impulse conditions." Ya. E. Pokrovskiĭ. *Zh. éksper. teor. Fiz.*, **24**, *No.* 4, 486–7 (1953) *In Russian.*

See preceding abstract. Tolpygo's criticism is refuted, as based partly on an approximate solution of a system of equations, and partly on an inexact equation found in the author's previous paper [Abstr. 7045 (1951)], which is now corrected. F. LACHMAN

537.585

10298. Effect of vapours of halogen compounds on the emission of positive ions from platinum. N. Sasaki and M. Onchi. Letter in *Nature* [*London*] **174**, 84–5 (*July* 10, 1954).

Experiments on the Rice effect (1944) are described. These lead the authors to suggest that the Rice effect may be due to the production of some new species of positive ions in some way by a surface reaction between O_2 and vapours of halogen compounds which seem to be related to the presence of alkali ions. A. H. W. BECK

537.585 : 537.533.3 : 621.385.832

10299. The negative ion components of the electron beam in cathode-ray tubes, especially television picture-tubes. W. F. Niklas. *Philips Res. Rep.*, **9**, 122–30 (*April*, 1954) *In German.*

The electron beam of a c.r.t. also contains negative ions which inactivate the fluorescent screen. When in a c.r.t. with an electrostatic lens system a transverse magnetic field is superposed on the electrostatic field, it is possible to focus the ions on the screen in sharp points which are arranged according to the mass of the ions. A sharp focus is only obtained if the ions are generated at the same spot as the electrons because the lens system is arranged for sharp focusing of these electrons. An unsharp focus of the ions therefore indicates that the ions must have been generated elsewhere than the electrons. The mass of the ions is obtained by suitable calibration. By means of the degree of sharpness of the focus, two ion components can be distinguished: ions coming from a cathode (cathode ions) and ions generated in the remaining gases contained in the c.r.t. (gas ions). By means of a fine network placed at different spots in the c.r.t. it is shown that the gas ions are generated between the grid and the first anode. From their mass and nature the cathode ions are identified as Cl^{37}, Cl^{35} and CN or C_2H_2, and the gas ions as O, CH, C. The reduction in the residual pressure results in the elimination of the gas ions; the intensity of CN (or C_2H_2) cathode ions becomes less with increasing life of the tube. A.

COSMIC RAYS 537.591

537.591 : 537.534

10300. The acceleration of charged particles moving in a magnetized medium. A. A. Logunov and Ya. P. Terletskiĭ. *Zh. éksper. teor. Fiz.*, **26**, *No.* 2, 129–38 (1954) *In Russian.*

The mechanism of the acceleration of a charged particle entering a region of uniform magnetic field is analysed, and formulae for the rate of gain of energy are derived when the radius of curvature is either smaller or greater than the dimensions L of the region. The resulting spectrum of primary cosmic-ray nuclei should be effectively cut off at a critical

energy varying as (mass number).$^{2/3}$ For protons this would be $\sim 10^{17}$–10^{18} eV, if $L \simeq 10^{20}$ cm and the velocities of the magnetic clouds are ~70 km/sec.

W. J. SWIATECKI

537.591.1

10301. Production of cosmic radiation at the sun. J. W. FIROR, J. A. SIMPSON AND S. B. TREIMAN. *Phys. Rev.*, **95**, 1015–19 (*Aug.* 15, 1954).

A calculation is made of the average production rate of 4 Bv cosmic-ray particles at the sun. The calculation is based upon the recent experimental evidence that the frequently occurring small solar flares produce temporary increases of neutron intensity in suitably located neutron pile detectors. This production rate, averaged over the 11-year solar cycle, is somewhat in excess of the absorption rate of 4 Bv particles by bodies in the solar system. If the production at the sun is to account for most of the observed cosmic radiation intensity, a trapping magnetic field is required. Limits on the size of such a trapping volume are estimated by considering the limits of cosmic-ray lifetime; the requirement of a high degree of radiation isotropy at the earth is satisfied. The existence of high-energy particles in the cosmic radiation imposes the principal difficulty for any solar origin hypothesis. A.

537.591.15

10302. Cloud chamber study on the second maximum of the Rossi wave in cosmic rays under lead. M. M. BISWAS. Letter in *Sci. and Culture*, **19**, 514 (*April*, 1954).

Cloud chamber photographs were taken under 12 and 16 cm Pb. No unusual type of shower, which could account for the second maximum, was observed. H. ELLIOT

537.591.15

10303. The multiple core structure of air showers. W. P. DAVIS, W. E. HAZEN AND R. E. HEINEMAN. *Nuovo Cimento*, **12**, 233–42 (*Aug.*, 1954).

The lateral density distribution of electrons in air showers has been observed at 3260 m altitude with an assembly of ionization chambers. The resolution was about 20 cm for $1/r$ peaks within the main array of 18 chambers. The absolute intensity of showers of size $10^5 < N < 10^6$ agrees with previous observations. Multiple peaks were observed and their spatial distribution indicates a mean separation of about 50 cm. The problem of a model for the production of the multiple-cored showers that is consistent with the observations is described. A.

537.591.15

10304. Narrow shower of pure photons at 100 000 feet. M. SCHEIN, D. M. HASKIN AND R. G. GLASSER. Letter in *Phys. Rev.*, **95**, 855–7 (*Aug.* 1, 1954).

Discusses an unusual event observed in a stack of nuclear emulsions flown at 100 000 ft. A shower of 16 electron pairs was produced without any associated incident charged particle except for the first of the electron pairs which had already materialized before entering the emulsion. The number of pairs materialized increases approximately linearly with distance and this leads to an estimate of 21 ± 3 for the number of incident photons in the shower. The cone enclosing the particles has a half-angle $\theta \leqslant 0{\cdot}001$ radian. Some possible interpretations are briefly discussed. H. ELLIOT

537.591.5

10305. Low-energy events in cosmic radiation. L. REIFFEL AND G. M. BURGWALD. *Phys. Rev.*, **95**, 1294 (*Sept.* 1, 1954).

The intensity of low-energy events in the cosmic radiation has been examined as a function of altitude with an energy-gated scintillation counter. Events selected were those giving pulses the equivalent of 0·2 MeV to 2·0 MeV electron energy loss in the scintillation crystal. Compared with data for total radiation, the present results show a shift toward lower altitudes by an almost constant fraction of a radiation length. A.

537.591.8

10306. Angular distributions in cosmic ray stars at 3 500 meters. M. CONVERSI AND P. ROTHWELL. *Nuovo Cimento*, **12**, 191–210 (*Aug.*, 1954).

Cosmic-ray stars have been investigated at 3500 m using an ion chamber surrounded by G.M. counters connected to a 22 channel hodoscope. The events were recorded by a tele-typewriter triggered by the hodoscope, so that a reconstruction of the mutual positions of the stars prongs could be obtained for each event. The analysis reported here refers to about 13 000 stars having either at least one secondary branch able to cross 1·2 g/cm² of brass or no such branch. These "detectable prongs" were protons of energy greater than 25 MeV or mesons of energy greater than 10 MeV. Using photographic emulsion results it is shown that the average energy, $\overline{W}$, of the nucleons producing these interactions is about 60 MeV for the stars without detectable prongs and in the neighbourhood of 750 MeV for the stars having at least one prong. The zenith angle distribution of these nucleons is well represented by $\cos^m z$ and m varies from $2{\cdot}1 \pm 0{\cdot}3$ to $2{\cdot}6 \pm 0{\cdot}3$ between $\overline{W} = 60$ MeV and $\overline{W} = 750$ MeV. It is found, furthermore, that roughly the same distribution holds for both proton and neutron forming stars. The angular distributions of the secondary prongs have been deduced with respect to the vertical and to the direction of the primary. Analytical expressions in terms of power of the cosine of the angle are obtained for the experimental distributions referring to the projections of the tracks on a plane. The distributions in space are derived from these plane distributions through the solution of an integral equation, and they are polynomials of the same type. Comparison of these distributions with those obtained from analysis of stars produced by 300–400 MeV nucleons, suggests that: (*a*) the cross-section for meson production is still very small at energies of 700–800 MeV; (*b*) the cross-section for elastic scattering in nucleon-nucleon interactions remains probably almost constant between 300 and 750 MeV. A.

537.591.8

10307. Sea-level mesons stopped in thin Pb and Al foils. I. Possible emission of charged nuclear particles and related events. W. Y. CHANG. *Phys. Rev.*, **95**, 1282–7 (*Sept.* 1, 1954).

Further cloud-chamber experiments are described on the stopping of sea-level mesons in thin foils of

Pb (5 of 0·009 and 6 of 0·018 in.) and Al (8 of 0·004 and 3 of 0·032 in.). Eighty-one negative μ-mesons are seen to stop in the Pb foils (50 in the thick foils and 31 in the thin ones). Only two cases show some evidence of slow proton or α-emission, as indicated by a heavy dot at the end of the stopped negative meson. In the case of Al, there are 36 negative mesons stopped, 12 and 24 in the thin and thick foils, respectively. None of these cases gives any observable evidence of a nuclear event at the place where the negative meson stops. From these statistics, upper limits have been estimated for the probability of nuclear ejection of protons and α-particles of different energies. It is thus found that, to be ejected from a Pb nucleus with reasonable probability, a proton must have an energy between 3 and 12 MeV, in agreement with the emulsion results of other workers. For Al, since no nuclear event has been observed, it is concluded that the maximum probability of nuclear ejection must be less than 10% for a proton of an energy in the above range. An α-particle in this energy range is improbably emitted from either an Al or a Pb nucleus. As in the previous experiments, no long-track and narrow-angle electron pairs have been observed in either Pb or Al which can be attributed to high-energy photons over 15 MeV emitted from the stopped negative μ-meson (or decaying meson). Thus no high-energy γ-rays are found and there is evidence for the rarity of even low-energy nuclear events. Consequently the same conclusions are drawn as in earlier less extensive experiments: that following the nuclear interaction only a small part of the μ-meson's rest energy is imparted to the nucleus, and that the remaining part must go off as neutral, non-electromagnetic radiation, to escape observation in the cloud chamber. Altogether, 87 decaying mesons have been actually found from the two (previous and present) series of experiments. None of the decay electrons has been seen to move toward any one of the anticoincidence counters below the chamber. From this fact, the solid angle covered by the anticoincidence counters, and the absorbing material above the counters, one argues that the proportion of μ-decay electrons with energy smaller than 10 MeV is of the order of 1 in 60 or less. A.

537.591.8

10308. Sea-level mesons stopped in thin Pb and Al foils. II. Low-energy (1–5 MeV) gamma rays. W. Y. Chang. *Phys. Rev.*, **95**, 1288–93 (*Sept.* 1, 1954).

Low-energy γ-rays (1–5 MeV) associated with the stopped negative μ-mesons, similar to those reported before, have been observed also in these experiments. Twenty-five meson-oriented electrons and pairs have been found in Pb associated with 23 of the 81 stopped negative μ-mesons. They are "meson-oriented" in the sense that the single electron track (or apex of the pair) makes an angle less than $\pm 20°$ with the imaginary line running back to the end point where the meson is stopped. None of such events has been obtainable from Al. Of the 25 directed events, 4 are single electrons emitted directly from the end point of the stopped negative μ-mesons, one being fairly energetic and the other three rather slow. The other 21 are single electrons and pairs observed in each case at a foil different from that where the meson stops and are meson-oriented in the above sense. The reality of this angular correlation follows from the fact that the 81 photographs of negative mesons stopped in Pb show only 6 electron tracks which make an angle of $90° \pm 20°$ with the line back to the end point of the meson track (6/21 as many tracks for 6 times as much solid angle). An independent determination of the rate of the strays was made by examining a film of 575 pictures to see how many tracks point by chance toward or away from an arbitrary point in the chamber with a 20° tolerance. From both ways of counting accidentals it is concluded that, of the 21 meson-oriented events, at most about $\frac{1}{3}$ can be explained as stray tracks. A crude analysis of the electron range in the Pb foils indicates that the majority of the "oriented electrons" and "oriented pairs" may be interpreted as having an energy of about 5 MeV and the rest an energy probably below 3 MeV. The multiplicity of the photons producing these electrons has also been estimated, after a correction has been made for the multiple scattering of the electrons in the first foil, where they are emitted, so as to include all the electrons other than those counted within the cone ($\pm 20°$) in the forward direction of the photons. The value for the multiplicity obtained is about 4·5 per negative meson stopped. The energy and frequency of occurrence of these photons are thus consistent with that predicted in Wheeler's theory of meson transition between the Bohr orbits and with that expected from nuclear de-excitation following the μ-meson capture. A.

MAGNETISM 538

538.083.9 : 621.317.44

10309. Measurement of two-dimensional fields. I. Theory. W. C. Elmore and M. W. Garrett. *Rev. sci. Instrum.*, **25**, 480–5 (*May*, 1954).

An arbitrary two-dimensional magnetic field may be uniquely specified by listing all coefficients of the power-series expansion of its complex potential function. An experimental procedure is described in which the first N coefficients are derived from an N-point harmonic analysis of the radial component of field or gradient, as measured with a dipole or quadrupole search coil at N equally spaced angular positions about an arbitrary longitudinal axis. The method may be refined by mounting two coils coaxially on a radial arm, so connected as to balance out the strongest component present and permit more accurate determination of the higher harmonics. With four coils, odd or even harmonics also may be suppressed. Analysis of the symmetry of various magnet pole structures shows that many of the coefficients vanish identically. Procedures are outlined for measuring with a quadrupole search coil the five independent elements of the magnetic gradient dyadic at a point in an unrestricted field. It is shown that in the fringing region at the ends of a long magnet gap the axial average of the transverse field can be treated as a two-dimensional field. It is correctly measured using line dipole or quadrupole search coils, whose design is prescribed. The procedure is identical with that for

the two-dimensional case. A further extension of the same method to measurements made with the electrolytic tray analogue increases greatly their speed and accuracy. A.

538.083.9 : 621.317.44

10310. The measurement of two-dimensional fields. II. Study of a quadrupole magnet. I. E. DAYTON, F. C. SHOEMAKER AND R. F. MOZLEY. *Rev. sci. Instrum.*, **25**, 485–9 (*May*, 1954).

The characteristics of a d.c. quadrupole magnet have been measured using some of the techniques proposed in the preceding paper. Saturation curves and measurements of the flux distribution in the magnet are presented. The characteristics of the magnet have been determined both in the interior and in the fringing region at each end. It is shown that by using a pole tip of circular cross-section and correctly chosen radius it is possible to produce a magnetic field with gradient constant to $\pm 1\%$ out to 0·8 of the radius of the gap. A.

538.114

10311. The three-dimensional face centred cubic ferromagnet. D. TER HAAR AND E. DEMPSEY. Letter in *Physica*, **20**, 437–9 (*July*, 1954).

Gives an application of the Kramers–Wannier variational treatment. The partition function, configurational energy and specific heat are calculated in series form above and below the Curie point and compared with the exact series expansions due to Trefftz [Abstr. 7401 (1950)]. E. P. WOHLFARTH

538.114

10312. Spinwaves in ferromagnetic and antiferromagnetic crystals. I. Ferromagnetism. J. VAN KRANENDONK. *Ned. T. Natuurkde.*, **20**, 121–39 (*June*, 1954) *In Dutch.* Review article.

538.114

10313. Spinwaves in ferromagnetic and antiferromagnetic crystals. II. Antiferromagnetism. J. VAN KRANENDONK. *Ned. T. Natuurkde.*, **20**, 161–77 (*July*, 1954) *In Dutch.* Review article.

538.22 : 532.73

Theory of magnetic properties of solutions of metals in liquid ammonia. *See Abstr.* 9974

538.22 : 539.132

10314. The principal magnetic susceptibilities of the maleic acid molecule HOOC–HC : CH–COOH. M. P. GUPTA. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, 643–4 (*July*, 1954).

Recent X-ray diffraction data enable these to be calculated from the crystal susceptibilities as: $X_L = -41{\cdot}99\times10^{-6}$ e.m.u. (in plane of molecule, perpendicular to C = C bond), $X_M = -44{\cdot}27\times10^{-6}$ e.m.u. (along C = C axis), and $X_N = -62{\cdot}32\times10^{-6}$ e.m.u. The large out-of-plane anisotropy $X_N - X_M$ (~ that of benzene) indicates contributions from the ring structure with a 2·46 Å internal H bond. J. HAWGOOD

538.221

10315. Ferromagnetic properties in millimetre waves. V. K. ARKAD'EV AND K. A. VOLKOVA. Letter in *Zh. éksper. teor. Fiz.*, **24**, *No.* 4, 501 (1953) *In Russian.*

Short sections of Fe and Ni wires of 1 mm diam. were placed in the focus of a concave mirror converging the waves of a mass emitter. Fe showed resonance with 2·4 mm, Ni with 5·3 mm waves. At the same time a magnetic field was applied parallel to the resonators, and the field intensity was determined, at which the wires were raised to the highest temperature; this maximum points to μ_R, i.e. to the fact that the electric resonator at the same time resonates with the magnetic field of electric oscillations generated in the resonator. F. LACHMAN

538.221

10316. Width of the line of the ferromagnetic resonance absorption. E. A. TUROV AND S. V. VONSOVSKIĬ. Letter in *Zh. éksper. teor. Fiz.*, **24**, *No.* 4, 501–3 (1953) *In Russian.*

In accordance with the (*s–d*)-exchange model [Abstr. 10634 (1954)], the energy operator of the system of N inner ferromagnetism electrons and N_s external conductivity electrons can be divided into 2 parts, one of which represents approximately the small disturbance which causes transitions between the levels of the ferromagnons and conductivity electrons. Further development of this partial operator results in its splitting into two parts, one of which corresponds to processes mentioned in Bloembergen's paper [Abstr. 7361 (1950)]. Under a certain simple assumption, the formulae developed yield the line-width magnitude which agrees well with experimental data and does not contradict the temperature dependence observed. The formula does not seem to be applicable at 0°K. F. LACHMAN

538.221

10317. On a non-magnetic state found in the irreversible Fe–Ni alloys. Y. TINO. *J. Sci. Res. Inst.* [*Tokyo*] **47**, 7–11 (*March*, 1953).

Reports magnetization, temperature measurements for alloys with Ni concentrations up to 30% and observes thermal hysteresis phenomena for the more Ni-rich alloys. These phenomena are interpreted by supposing these alloys to be mixtures of α- and γ-phases, leading to fluctuations of the magnetization. [No reference is made to the more exhaustive earlier experiments due to Sucksmith *et al.*] E. P. WOHLFARTH

538.221

10318. The temperature dependence of ferromagnetic resonance in colloidal nickel. D. M. S. BAGGULEY AND N. J. HARRICK. Letter in *Proc. Phys. Soc.* [*London*] *A*, **67**, 648–9 (*July*, 1954).

Previous work [Abstr. 591 (1954)] has been extended to investigate line width and spectroscopic splitting factor between 20°K and 750°K, a discontinuity in the value of both these quantities being found near the Curie point. Results are plotted over the whole temperature range covered and are briefly interpreted in the light of theoretical considerations. G. F. HODSMAN

538.221

10319. On the ferrimagnetism of iron selenides. T. HIRONE, S. MAEDA AND N. TSUYA. *J. Phys. Soc. Japan*, **9**, 496–9 (*July–Aug.*, 1954).

The thermomagnetic properties of iron selenides $FeSe_x$ with various selenium contents x were measured as functions of temperature. The thermomagnetic curves obtained belong to the ordinary Weiss type. It was also found that the magnetization at the boiling

temperature of liquid nitrogen increases with the selenium content, reaches its maximum value, 35 gauss., at $x = 1{\cdot}23$, and then decreases again with further increase of x. The Néel temperature was approximately 150°C in the range of x from 1 to 1·26 whereas it decreases gradually with further increase of x and approaches to its lowest value 30°C at $x = 1{\cdot}35$. The origin of the magnetization of this substance was discussed using the theory of ferrimagnetism. A.

538.221

10320. Thermal analysis of iron sulfides at the temperature range of β-transformation. T. Hirone, S. Maeda, S. Chiba and N. Tsuya. *J. Phys. Soc. Japan*, **9**, 500–2 (*July–Aug.*, 1954).

The measurements of specific heat was performed at the temperature range of β-transformation in iron sulphides with various sulphur contents x ranging from $x = 1$ to $x = 1{\cdot}12$. A peak in specific heat versus temperature curve is found at 315°C, and this temperature as well as the jump in specific heat, 0·05 cal. g^{-1}. deg^{-1} in value, is almost independent of sulphur contents. The mechanism of transformation is discussed, based upon the theory of ferrimagnetism, and it is concluded that the present experimental results accord well with the theoretical ones. A.

538.221

10321. Thermal analysis of iron sulfides at the temperature range of α-transformation. T. Hirone, S. Maeda and N. Tsuya. *J. Phys. Soc. Japan*, **9**, 503–6 (*July–Aug.*, 1954).

The specific heat of iron sulphides near stoichiometric composition from $FeS_{1\cdot00}$ to $FeS_{1\cdot07}$ at the temperature range of α-transformation was measured. It was found that the curves of specific heat versus temperature had a comparatively sharp A-shaped maximum. Both the temperature for such a maximum and the peak values of specific heat decreased with the increase of sulphur contents. It was also found that the heat absorption due to this transition also decreased with the increase of excess sulphur, its value being about 550 cal.mol^{-1} at the stoichiometric compound, and vanishing at the composition $FeS_{1\cdot07}$. The several possible models for the mechanism of this transition are discussed taking into account the above experimental results. A.

538.221

10322. On nickel oxides of high oxygen content. Y. Shimomura, I. Tsubokawa and M. Kojima. *J. Phys. Soc. Japan*, **9**, 521–4 (*July–Aug.*, 1954).

Nickel oxides of high oxygen content formed by incomplete dissociation of nickel nitrate were investigated crystallographically and magnetically. The oxygen excess of these oxides ranges from zero to 0·2 g atom/mol, and their crystal structures are not essentially different from that of the ordinary nickel oxide. As they are not in a stable state, their behaviour is unusual. That is, with the degree of excess, they come to have a cubic structure the parameter of which is larger than that of a rhombohedrally deformed one, and at sufficiently high oxygen contents they behave somewhat like ferromagnetics. Such rather extraordinary phenomena may be considered to originate in the fact that the oxygen excess in the specimens causes not only nickel vacancies but also absolute excess of anions. In the measurements of susceptibility, the coincidence between the heating and cooling curves is very good for ferromagnetic-like oxides, while it is not for antiferromagnetic ones. There is also evidence for the existence of antiferromagnetic cubic oxide at a temperature lower than its Néel point. A.

538.221

10323. The magnetic anisotropy of cobalt. W. Sucksmith and J. E. Thompson. *Proc. Roy. Soc. A*, **225**, 362–75 (*Sept.* 14, 1954).

A modified form of the magnetic balance is described. In this apparatus the gradient is made independent of the magnetizing field. With such an apparatus measurements have been made on the variation of the intensity of magnetization with magnetic field for single-crystal specimens cut along appropriate crystal axes, both for the hexagonal close-packed and face-centred cubic cobalt. Such measurements enable the magnetic anisotropy constants to be determined. The nature of the phase change from close-packed hexagonal to face-centred cubic occurring at about 400°C is such that single crystals can be cut at room temperature, which will transform to give single crystals of known orientation in the face-centred cubic phase. The values of the magnetic anisotropy constants for the hexagonal phase for various temperatures are compared with those of earlier determinations and fair agreement is found. Measurements on the face-centred cubic phase were made every 50°C in the temperature range 500 to 1000°C; at the latter temperature the material became magnetically isotropic. For face-centred cubic cobalt it was found that the crystal directions in order of increasing difficulty of magnetization are [111], [110] and [100], as is the case for nickel. Moreover, the value of the anisotropy constant k_1 obeys the same empirical law, giving the variation with temperature, as nickel. The similarity in the magnetic behaviour of these two ferromagnetics having the same crystal structure is thus evident. A.

538.221 : 538.114

10324. The theory of ferromagnetic resonance and the results of its experimental investigation. K. H. Reich. *Z. angew. Phys.*, **6**, 326–38 (*July*, 1954) *In German.*

A review of the following topics: Classical, quantum mechanical derivation of the resonance condition, g and g' factors, effect of specimen shape and magnetocrystalline anisotropy, experimental results for metals, alloys and ferrites (g and g' values are tabulated). 83 references up to Oct., 1953; later references are given in footnotes and an appendix.

E. P. WOHLFARTH

538.221 : 538.652

10325. The magnetostriction constants of silicon steel. I. H. Takaki and Y. Nakamura. *J. Phys. Soc. Japan*, **9**, 507–11 (*July–Aug.*, 1954).

By the use of long single-crystal rods of 0·7% and 1·8% silicon steel, having various crystallographic orientations, prepared by the strain-anneal method, magnetization and magnetostriction were measured at

room temperature by the usual ballistic and optical methods respectively. It was found that in both materials Kaya's law with regard to the residual magnetization holds satisfactorily and on its basis their magnetostriction constants λ_{100} and λ_{111}, and also their crystal anisotropy constants K_1 were determined. Gradual decrease of these three constants with silicon content was confirmed. A.

538.221 : 539.185

10326. Magnetic neutron diffraction from Fe_3O_4. A. W. McReynolds and T. Riste. *Phys. Rev.*, **95**, 1161–7 (*Sept.* 1, 1954).

By neutron diffraction intensity measurements, the spin alignment structure has been studied from the room temperature to above the Curie point in an unmagnetized (random domain orientation) crystal of Fe_3O_4. Intrinsic magnetization is found to follow approximately the Weiss theory and to go to zero at a sharply defined Curie point, where domain structure disappears. An additional diffuse component of the magnetic Bragg peaks is observed to be independent of external fields and indicates transient short-range ordering of spins, which reaches a sharp maximum at the Curie point but exists at both higher and lower temperatures. A.

538.221 : 621.318.1

10327. Low-loss ferrites for applications at 4000 megacycles per second. L. G. Van Uitert, J. P. Shafer and C. L. Hogan. Letter in *J. appl. Phys.*, **25**, 925–6 (*July*, 1954).

Faraday rotation and loss curves at 4000 Mc/s are shown for 3 Mg ferrites having a general formula $MgAl_xMn_yFe_{2-(x+y+z)}O_4^{\pm}$. At 4000 Mc/s, initial low field loss is completely absent only when the intrinsic saturation moment is < 1430 gauss., the measured saturation moment being 800 gauss. [Abstr. 1273 (1948)]. J. H. MASON

538.222

10328. Molecular structure and related problems. Paramagnetic resonance absorption of copper fluorsilicates. Y. Yokozawa. *Monogr. Res. Inst. Appl. Elect. Hokkaido Univ.*, *No.* 4, 95–103 (1954).

Measurements on undiluted salts give $CuSiF_6.4H_2O$, monoclinic, $g_\perp$ 2·10, $g_{||}$ 2·40, all Cu ions equivalent, L–S coupling constant $-$ 828 cm^{-1}, and cubic field separation, ΔE 16 600 cm^{-1}. $CuSiF_6.6H_2O$ is trigonal with g 2·20 (isotropic) and ΔE 16 600 cm^{-1}.

D. H. WHIFFEN

538.222

10329. Anomalous paramagnetic resonance dispersion and absorption in crystal powders. E. Lutze. *Naturwissenschaften*, **41**, *No.* 12, 279–80 (1954) *In German.*

The paramagnetic resonance dispersion, as well as the loss, is measured at 9000 Mc/s and 3000 gauss. for FeF_3 4·5 H_2O and the curve shown to be in fair agreement with that calculated from the loss.

D. H. WHIFFEN

538.222

10330. Spin coupling in a molecule containing three chromic ions. Magnetic properties between 1·6°K and 293° K of the complex acetate $[Cr_3(CH_3COO)_6(OH)_2]Cl.8H_2O$. J. Wucher and H. M. Gijsman. *Physica*, **20**, 361–6 (*July*, 1954) *In French.*

Describes results of susceptibility determinations. The results are interpreted on the basis of a spin Hamiltonian of anisotropic form. The values of the coupling constants are derived [see Abstr. 967 (1953)]. E. P. WOHLFARTH

538.222

10331. Thermomagnetic properties of the complex mixed acetate $[Cr_2Fe(CH_3COO)_6(OH)_2]Cl.6H_2O$. H. M. Gijsman, T. Karantassis and J. Wucher. *Physica*, **20**, 367–71 (*July*, 1954) *In French.*

Describes results of susceptibility determinations between 1·4° and 320°K. The results are interpreted on the basis of an isotropic spin Hamiltonian with an interaction energy between the three spins of amount $40\,k$. See also preceding abstract. E. P. WOHLFARTH

538.222

10332. Paramagnetic resonance in gadolinium sulphate octohydrate. G. S. Bogle and V. Heine, Jr. Letter in *Proc. Phys. Soc.* [*London*] *A*, **67**, 734–6 (*Aug.*, 1954).

538.222

10333. Paramagnetic resonance absorption in a soft carbon. J. G. Castle, Jr. Letter in *Phys. Rev.*, **95**, 846–7 (*Aug.* 1, 1954).

Variation of paramagnetic resonance line widths for carbon with heat treatment to various temperatures from 1500–3000°C shows maxima at about 1750 and 2350°C, for which treatment temperatures the Hall coefficients become zero. D. H. WHIFFEN

538.222

10334. Crystal magnetism of tourmaline. M. Leela. *J. Mysore Univ. B*, **14**, 21–31 (*Sept.*, 1953).

Principal crystal susceptibilities of tourmaline of different colours have been determined and the results are discussed with respect to the theoretical aspects of paramagnetism. Crystals containing Fe^{++} and Cr^{++} exhibit a large paramagnetism and anisotropy, those containing Cr^{+++} and Fe^{+++} show large paramagnetism and small anisotropy, while those containing Mn show small paramagnetism and anisotropy. A. E. DE BARR

538.222 : 536.48

10335. Magnetic and thermal properties of chromic methylamine alum below 1°K. R. P. Hudson and C. K. McLane. *Phys. Rev.*, **95**, 932–40 (*Aug.* 15, 1954).

The earlier measurements of de Klerk and Hudson on a spherical mass of small crystals of chromic methylamine alum have been repeated, and extended, using a one-inch sphere ground from a large single crystal. The variation of susceptibility with entropy follows closely—down to 0·1°K—the predictions of the theory of Hebb and Purcell when a suitable choice is made for the value of δ, the splitting between the two spin-doublets in the ground level of the Cr^{+++} ion. It is found that $\delta/k = 0{\cdot}269 \pm 0{\cdot}003$ degree. Measurements have been made of the ballistic susceptibility χ, remanent magnetic moment Σ, and the in-phase and out-of-phase components of the a.c. susceptibility, χ' and χ'' respectively (these latter being measured at both 150 c/s and 210 c/s). The variation

of χ' with entropy S is found to agree closely with that reported for the powder specimen, except in the region of the susceptibility maximum where the behaviour appears to depend upon the rate of precooling the specimen. At approximately the same entropy as that corresponding to maximum χ', χ'' shows an extremely sharp maximum. The ballistic susceptibility depends upon the measuring field in the region of the maximum; remanence appears here and goes through a maximum as the entropy is reduced. The remanence maximum is found at a lower entropy the larger is the measuring field. Associated with this hysteresis are very marked "time-effects" in the adjustment of the magnetization to a change in measuring field, as encountered in tracing out hysteresis loops. Measurements of the susceptibility in superimposed steady magnetic fields of 0–500 oersted show unusual behaviour below the Curie point and suggest the existence of anisotropy. For application of the field along a cubic axis, a magnetization of about one-half the saturation value appears to have special significance; this value is attained in fields as small as 150 oersted, but increasing the field up to about 500 oersted produces little further change in the magnetization. A.

538.222 : 536.48

10336. Measurements on chromium potassium alum below 1°K. E. Ambler and R. P. Hudson. *Phys. Rev.*, **95**, 1143–4 (*Sept.* 1, 1954).

Measurements of the real part, χ', and imaginary part, χ'', of the a.c. susceptibility, the ballistic susceptibility and the remanence were made on chromic potassium alum in the range of temperature below 1°K. The results provide confirmation of earlier measurements in the region above 0·1°K, but show some discrepancies at lower temperatures, particularly in the behaviour of χ''. Some absolute temperature determinations, in the region of the Curie point, were also made and these are of particular interest in view of wide discrepancies between such measurements made at Oxford and at Leiden. A.

538.222 : 539.152.2

10337. Paramagnetic resonance in plutonyl rubidium nitrate and the spin of ^{239}Pu. B. Bleaney, P. M. Llewellyn, M. H. L. Pryce and G. R. Hall. Letter in *Phil. Mag.*, **45**, 773–4 (*July*, 1954).

The resonance was observed at wavelengths of 3·2 and 1·5 cm at 20°K in a single crystal magnetically diluted with the isomorphous uranyl salt. Two lines of equal intensity were observed, indicating that the spin of Pu^{239} is $\frac{1}{2}$, in agreement with optical observations. The behaviour of the lines as the field is rotated relative to the crystal axis is compatible with the assumption that all the plutonyl ions are magnetically equivalent and uniaxial, and in agreement with theoretical expectations based on the hypothesis that the magnetic electrons are in the 5*f* shell.

L. PINCHERLE

538.222 : 541.6

10338. Paramagnetic resonance in some molecular compounds; a new class of biradicals. H. Kainer, D. Bijl and A. C. Rose-Innes. *Naturwissenschaften*, **41**, *No.* 13, 303–4 (1954).

The lowest state of a 1 : 1 molecular compound is usually formed by the attraction due to van der Waals forces between the molecules; the next states are ionic: a singlet state usually near the lowest state and a triplet state much higher. If the molecules differ greatly in electro-negativity the ionic states might become the lower and the triplet state could on longer be neglected. Thus the compound might be paramagnetic. This was investigated for a number of "biradical molecular compounds" consisting of aromatic diamines and quinones. A number of complexes containing *p*-phenylene diamine were found to be paramagnetic. The colour of solutions of such compounds in polar solvents also suggests a preference for splitting into ions over splitting into molecules, which is likely to happen in the colourless solutions in non-polar solvents. A. J. TAYLOR

538.224

10339. The Dorfman diamagnetic resonance effect. S. A. Al'tshuler, B. M. Kozyrev and S. G. Salikhov. Letter in *Zh. éksper. teor. Fiz.*, **24**, *No.* 4, 503–4 (1953) *In Russian.*

See also Abstr. 7404 (1952). Measurements of the absorption of energy of the high-frequency magnetic field (room temperature, frequency range 10^8–10^{10} c/s) failed to disclose the presence of any resonance effect for Na, Al, Cr, Mn, Mo, Sb, Bi and other metals. It is suggested that a measurable effect can only be expected at liquid He temperatures. F. LACHMAN

538.24

10340. Spontaneous magnetization as a function of temperature for mixed crystals of ferrites with several Curie temperatures. K. F. Niessen. *Philips Res. Rep.*, **9**, 197–208 (*June*, 1954).

It is shown by an example how the spontaneous magnetization can be calculated as a function of temperature. A.

538.24

10341. The spontaneous magnetization of alloys and compounds. II. Ferrites. C. A. Clark and W. Sucksmith. *Proc. Roy. Soc. A*, **225**, 147–59 (*Aug.* 31, 1954).

For Pt I, see Abstr. 6960 (1953). Describes the second stage of a project to determine the temperature variation of spontaneous magnetization for various materials. An unequivocal determination of the spontaneous magnetization requires, in addition to magnetic intensities, the measurement of the magnetocaloric effect. Three extrapolation techniques were used to deduce the spontaneous magnetization from the observations, the results being considered with reference to Néel's theory of ferrimagnetism. Two typical ferrites, manganese ferrite and magnesium zinc ferrite, molecular compositions $MnO \cdot Fe_2O_3$ and $\frac{1}{2}MgO \cdot \frac{1}{2}ZnO \cdot Fe_2O_3$ respectively were selected for the investigation. Owing to the low conductivity of this class of substances particular care is required in the thermal measurements. The different extrapolation techniques lead to substantially the same values of the spontaneous magnetization. In contrast to the behaviour of the ferromagnetic metals, this agreement is maintained in the Curie point region, the spontaneous magnetization-temperature curves showing a smaller "tail" near the Curie temperature. For both materials the departure of the curve of

reduced magnetization against reduced temperature from that predicted by the quantum modification of the Weiss theory is verified by the present work. While the saturation magnetization of the ferrites and the reduced magnetization curve for manganese ferrite are in satisfactory agreement with Néel's theory, the variation with temperature for the specimen of magnesium zinc ferrite does not correspond to any of the solutions predicted. A.

538.24 : 548.736.5

10342. Saturation magnetization and crystal chemistry of ferrimagnetic oxides. E. W. GORTER. *Philips Res. Rep.*, **9**, 295–320 (*Aug.*, 1954).

Measurements of the saturation magnetization (σ) against temperature are carried out for a number of mixed crystal oxides with spinel structure. The results are in agreement with Néel's theory of ferrimagnetism: the resultant magnetic moment m is the difference of the moments of the tetrahedral (A) and octahedra (B) sublattices, either (a) with complete parallelism of the ionic moments inside each sublattice, or (b) with angles between the ionic moments inside one of the sublattices. A.

538.242

10343. Agreement of measurements of gyromagnetic ratios after correction of a systematic error in certain experiments. S. BROWN, A. J.-P. MEYER AND G.-G. SCOTT. *C.R. Acad. Sci.* [*Paris*] **238**, 2502–4 (*June* 28, 1954) *In French.*

Differences between the results obtained by Barnett, Meyer and Scott are shown to be a result of a systematic error in the optical system used in Meyer's and Scott's experiments. Corrected values of $\rho.e/m$ for the ferromagnetic elements are now as follows:

	Fe	Co	Ni
Barnett ..	1·035	1·078	1·046
..	±0·003	±0·007	±0·004
Meyer ..	1·033	—	1·040
..	±0·004	—	±0·002
Scott ..	1·038	1·079	1·089
..	±0·001	±0·004	±0·002

Revised values are also given for some interferromagnetic alloys. E. P. WOHLFARTH

538.245 : 548.7

10344. A theory of domain creation and coercive force in polycrystalline ferromagnetics. J. B. GOODENOUGH. *Phys. Rev.*, **95**, 917–32 (*Aug.* 15, 1954).

Granular inclusions, grain boundaries, lamellar precipitates, and the crystalline surface have been examined as possible nucleation centres for domains of reverse magnetization in ferromagnetic materials. It is concluded that the surface density of magnetic poles at the grain boundaries ω^* is the most common source of nucleation energy in polycrystalline materials. The concept of nucleation of domains of reverse magnetization has led to a calculation of three more terms which may contribute to the coercive force in polycrystalline materials, viz. a grain-boundary, a lamellar-precipitate and a domain-wall-surface-tension contribution. The theoretical predictions are compared with several old experiments. New insight is gained on the problem of stress sensitivity of polycrystalline ferromagnetics and *B-H* loop shape. A.

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3

10345. The energy impulse tensor of the electromagnetic field and the ponderomotive forces in dielectrics. G. MARX AND G. GYÖRGYI. *Acta phys. Hungar.*, **3**, *No.* 3–4, 213–42 (1954) *In German.*

The calculation of the energy impulse tensor for electromagnetic fields in vacuum using the method of Lorentz forces is well known. The calculations for various fields in dielectric media are discussed here. C. A. HOGARTH

538.3

10346. The equation of motion of the magnetic dipole. G. MARX. *Bull. Acad. Polon. Sci. Cl.* 3, **2**, *No.* 5, 219–24 (1954).

The field due to a moving dipole of moment $\mathbf{m}$ is obtained as a power series in c^{-1}. The force on the dipole is calculated from considerations of field momentum and expressed in the form $\mathbf{K} + (\mathbf{m} \cdot \nabla)\mathbf{H} + \mathbf{E}\times\dot{\mathbf{m}}/c + (\dot{\mathbf{v}}\times\mathbf{m})\times\mathbf{H}/c^2$, where $\mathbf{E}$ and $\mathbf{H}$ are the intensities of the external field. The self-force term $\mathbf{K}$ is not discussed in the present note. R. A. NEWING

538.3

10347. Some consequences of the theory of action at a distance in classical electrodynamics. P. BRAFFORT, M. SPIGHEL AND C. TZARA. *C.R. Acad. Sci.* [*Paris*] **239**, 157–60 (*July* 12, 1954) *In French.*

The theory of action at a distance apparently avoids the difficulty of an infinite energy for a point charge, but the fluctuations of the absorber add an electromagnetic energy that may diverge for certain spectral distributions. Also, in this theory the fluctuations of the field may compensate the radiation damping of a harmonic oscillator. L. PINCHERLE

538.52 : 532.57

10348. Induction in a liquid stream of elliptical, circular, or rectangular section. M. ROBIN AND J. RANTZ. *J. Rech. Cent. Nat. Rech. Sci.*, **5**, 290–7 (*March*, 1954) *In French.*

A mathematical investigation of the voltage induced in a conducting liquid flowing in an insulating pipe and subject to a transverse magnetic field parallel to the small axis of the section. The potential difference in volts between the extremities of the larger axis, of length $2a$ cm, is found to be $u = 10^{-8}\mu H V_m 2a\lambda$, where μ is the magnetic permeability (c.g.s.), H is the field in oersted, V_m(cm/sec) the mean velocity of laminar flow, and λ is a numerical factor displayed graphically as a function of the ratio of major to minor axis. J. S. BELL

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.56 : 537.527

Self-excitation of auto-oscillations in a gas discharge at high pressure. *See Abstr.* 10224

538.561

10349. On the asymptotic behaviour of the solution of a problem in magneto-hydrodynamics. II. R. NARDINI. *R.C. Accad. Naz. Lincei*, **16**, 341–8 (*March*, 1954) *In Italian.*

The mathematical discussion of the results announced in Abstr. 7576 (1954) is continued.

R. A. NEWING

538.561 : 537.525.8

Low-frequency oscillations in the positive column of the glow discharge. *See Abstr.* 10223

538.566

10350. Diffraction of electromagnetic waves by an aperture in a large screen. L. LEWIN. Letter in *J. appl. Phys.*, **25**, 1053 (*Aug.*, 1954).

The lack of correspondence between experimental observations and the theory put forward by Bekefi [Abstr. 616 (1954)] and criticized by Crysdale [Abstr. 5815 (1954)] is attributed to their assumption of a particular, rather than a general solution for the magnetic Hertz vector. G. D. SIMS

538.566 : 534.24

Transmission and reflection by systems of cylinders. *See Abstr.* 9993

538.566 : 535.51 : 530.145

Polarization and the Stokes parameters. *See Abstr.* 9924

538.566 : 621.396.11

10351. Diffraction of plane radio waves by a parabolic cylinder. S. O. RICE. *Bell Syst. tech. J.*, **33**, 417–504 (*March*, 1954).

Expressions are given for the diffraction field far behind, and the surface currents on, a parabolic cylinder. Approximate values for the field strength and current density are given when the radius of curvature of the cylinder is large compared to a wavelength. The formulae may have value in predicting the shadows cast by hills in microwave propagation. The idea of representing hills by knife-edges has been used successfully by a number of investigators. The theory of the parabolic cylinder indicates that such a representation is valid even for gently rounded hills when the angle of diffraction is small. On the other hand, when the angle of diffraction is so large that the knife-edge calculations do not apply, the results presented here may be used. A.

538.566 : 621.372.8

10352. Attenuation coefficient of waveguides loaded by circular irises. R. COMBE. *C.R. Acad. Sci.* [*Paris*] **238**, 2063–5 (*May* 24, 1954) *In French.*

See also Abstr. 8454 (1954). An approximate derivation of the attenuation coefficient for the E_{01} mode. G. D. SIMS

538.566

10353. A method for measuring small angles of microwave Faraday rotation. P. J. ALLEN. *Rev. sci. Instrum.*, **25**, 394 (*April*, 1954).

When the planes of analyser and polarizer are at 45°, a square-law detector output voltage is proportional to angle of rotation for small angles. Rotations of 10^{-4} degree have been detected. Sources of error are mentioned. The effects of r.f. input power variations can be minimized by a two-detector method. W. T. BLACKBAND

538.566 : 621.372.8

10354. A contribution to the theory of right-angled junctions in wave guides. J. D. PEARSON. *Quart. J. Mech. Appl. Math.*, **7**, 194–202 (*June*, 1954).

The dimensions of one guide are such that more than one mode of wave may exist. Propagation through the junction is considered generally, and then details are presented for two cases: (1) second guide matched, (2) filter in second guide. Numerical results on the reflection and transmission coefficients are given. The mathematical method leads to an infinite system of linear equations, a truncated system being solved. L. S. GODDARD

538.566 : 621.372.8

10355. The elliptic surface wave. A. E. KARBOWIAK. *Brit. J. appl. Phys.*, **5**, 328–35 (*Sept.*, 1954).

Formulae are derived for the surface wave of the elliptic cylinder. The mode described is an *E*-mode that possesses the evanescent structure in the transverse plane of the cylinder. The elliptic surface wave is shown to be similar in some respects to the surface wave associated with single-wire transmission lines of circular symmetry to which form the elliptic surface wave degenerates when the eccentricity of the ellipse tends to zero. In a separate section a slightly deformed circular guide is discussed in detail and it is shown that the performance of a circular guide is substantially unaffected by slight deformation of its geometry. The last section of the paper deals with different types of elliptic guides that are likely to be encountered. The elliptic dielectric rod waveguide and a corrugated elliptical guide are typical examples, while the homogeneous metal guide and the dielectric coated perfectly conducting elliptical rod are analysed in detail. A.

538.566 : 621.318.134 : 621.372.8

10356. Faraday effect in magnetic materials with travelling and standing waves. H. G. BELJERS. *Philips Res. Rep.*, **9**, 131–9 (*April*, 1954).

The ferromagnetic Faraday effect in a circular waveguide is described and the approximate theory for the angle of rotation of the plane of polarization is recapitulated. A few experiments are described for Ferroxcube and Ferroxdure samples and the experimental results are compared with theory. An experiment with a ferrite specimen in a resonance cavity is reported, showing the positively and negatively rotating components of the mode of oscillation. A.

538.566.2

10357. On the validity of the Sommerfeld–Pfrang reciprocity theorem in absorbing media. C. VON FRAGSTEIN. *Optik*, **11**, *No.* 7, 301–11 (1954) *In German.*

The theorem relates to the propagation of electromagnetic waves. Its validity in absorbing media is investigated. Expressions are found for various intensity ratios (of the electric field), and these lead to the necessary modification. L. S. GODDARD

538.566.2

10358. On the radiation of the long waves of a horizontal dipole in the air cavity between the earth and ionosphere. II. W. O. SCHUMANN. *Z. angew. Phys.*, **6**, 267–71 (*June*, 1954) *In German.*

Continuation of Pt I [Abstr. 8455 (1954)] and concludes with a comparison of the results of this more

general treatment with those obtained by Sommerfeld for the simple case of perfect conducting boundaries. J. M. HOUGH

538.566.2 : 551.594.5

10359. A note on auroral interaction. N. C. GERSON. Note in *J. atmos. terrest. Phys.*, **4**, 81–2 (*Sept.*, 1953).

A mechanism for the interaction with radiowaves is suggested in terms of reflection by irregularities in the sides of the incoming stream of particles. It is shown that this could produce an effect of the right magnitude. J. M. HOUGH

538.566.2 : 621.3.018.756 : 621.396.821

10360. Atmospherics with long trains of pulses. F. HEPBURN AND E. T. PIERCE. *Phil. Mag.*, **45**, 917–32 (*Sept.*, 1954).

The waveforms of atmospherics having long-continued trains of pulses, and the systematic modifications associated with time of recording, storm distance and the presence of a l.f. component, are described. Their interpretation is discussed and the results of analysis—assuming the simple ionospheric reflection mechanism—are presented. Estimates of reflection height and storm distance show the applicability of the theory to the temporal parameters of the waveforms, and the origins of two groups of atmospherics having calculated ranges of 4500 and 7000 km are considered. The variation of pulse amplitude with reflection order is shown to lead to the postulation of horizontal radiating elements in the channel during the later stages of the return stroke, although difficulties arise in reconciling this concept with magnitude and orientation of the horizontal elements. A.

538.566.2 : 621.396.11

10361. Propagation of radio frequency energy through the earth. F. M. MCGEHEE, JR. *Geophysics*, **19**, 459–77 (*July*, 1954).

Measurements were made of some propagation characteristics in the earth of 1614 and 1700 kc/s energy. The experiments were conducted at Carlsbad Caverns, New Mexico, and Mammoth Cave, Kentucky. Transmitters were set up on the surface 710 ft above an unwired tunnel in Carlsbad Caverns and the signal strength was measured at many points in the tunnels. A similar series of measurements was made in Mammoth Cave in a tunnel 270 ft below the surface. The data show that the attenuation constant is about 0·012 and 0·02 to 0·064 neper/m at the two locations respectively. These values are in good agreement with theory. A.

MAGNETIC EFFECTS 538.6

538.61

10362. Magneto-optic study of some inorganic acids and their salts. V. SIVARAMAKRISHNAN. *J. Indian Inst. Sci. A*, **36**, 193–9 (*July*, 1954).

Measurements have been made of the optical and magneto-optical constants of aqueous solutions of HNO_3, H_2SO_4, $HClO_4$ and H_3PO_4 and some of their salts at different concentrations. From the observed data the constants for the ions in solution have been evaluated. It is found that while the dispersion in the acids increases, the Verdet constant decreases with concentration. This effect has been attributed to the presence of near u.v. bands which contribute towards dispersion but not towards Faraday rotation. The magneto-optical anomaly factor for these acids is very low; $\gamma(HNO_3) = 0{\cdot}2$, $\gamma(HClO_4) = 0{\cdot}38$, $\gamma(H_2SO_4) = 0{\cdot}53$, $\gamma(H_3PO_4) = 0{\cdot}62$, and the γ-value for the ions changes considerably with concentration. A.

538.63

10363. The ferromagnetic anisotropy of the specific resistance of some nickel alloys. H. C. VAN ELST AND C. J. GORTER. *Appl. sci. Res. B*, **4**, *No.* 1–2, 87–90 (1954).

538.63

10364. On the transverse magnetoresistance effect in InSb. H. WEISS AND H. WELKER. *Z. Phys.*, **138**, *No.* 3–4, 322–9 (1954) *In German.*

The dependence of the transverse magnetoresistance effect on the conduction type, the mobility of the charge carriers and the geometrical form of the semiconductor is calculated and compared with observations on InSb. Specimen shape is important for mobilities in excess of 10 000 cm^2/V sec. On Corbino-type specimens in InSb in a magnetic field of 10 000 gauss the resistance is 24·6 times greater than without the field. A. E. DE BARR

538.632

10365. Hall effect in ferromagnetics. C. KOOI. Letter in *Phys. Rev.*, **95**, 843–4 (*Aug.* 1, 1954).

Reports Hall and resistivity measurements at 77° and 300° on Fe and Fe–Si alloys with Si concentrations between 1·30 and 5·09%. The extraordinary Hall constant is related to the resistivity by the equation $R_1 = A\rho^n (A = 0{\cdot}89,\ n = 1{\cdot}9)$, except at low ρ-values. This equation is in good agreement with a theory based on the effects of spin-orbit coupling of the *d* electrons (Karplus and Luttinger). E. P. WOHLFARTH

538.632

10366. Hall effect in ferromagnetics. R. KARPLUS AND J. M. LUTTINGER. *Phys. Rev.*, **95**, 1154–60 (*Sept.* 1, 1954).

Both the unusually large magnitude and strong temperature dependence of the extraordinary Hall effect in ferromagnetic materials can be understood as effects of the spin-orbit interaction of polarized conduction electrons. It is shown that the interband matrix elements of the applied electric potential energy combine with the spin-orbit perturbation to give a current perpendicular to both the field and the magnetization. Since the net effect of the spin-orbit interaction is proportional to the extent to which the electron spins are aligned, this current is proportional to the magnetization. The magnitude of the Hall constant is equal to the square of the ordinary resistivity multiplied by functions that are not very sensitive to temperature and impurity content. The experimental results behave in such a way also. A.

538.653.1

10367. Regular inner stress in a single crystal produced from a rolled silicon steel plate. E. TATSUMOTO. *J. Sci. Hiroshima Univ. A*, **17**, 229–37 (*Dec.*, 1953).

Reports results of powder pattern and magnetostriction experiments on narrow single crystal Si steel

strips (1·08% Si, 0·50% impurity). Evidence is obtained for a regular internal stress distribution, the magnitude of the stress being estimated to be about 450 g.mm^{-2}, its direction being at right angles to the rolling direction. The stress is thought to be due to the observed presence of needle-like weakly ferromagnetic or non-ferromagnetic inclusions lying parallel to the rolling direction. The effect of externally applied stresses on the powder patterns was also investigated; the effect is marked at a stress 400 g.mm^{-2}, close to the estimated internal stress.

E. P. WOHLFARTH

538.66

10368. Investigation of the transverse thermomagnetic effect. N. M. GENKIN AND G. P. PRIPOROVA. *Zh. éksper. teor. Fiz.*, **26**, *No.* 3, 323–6 (1954) *In Russian.*

An expression analogous to that for the Hall effect is derived for the transverse e.m.f. produced by a heat flow through a conductor in the presence of a perpendicular magnetic field. Experimental work on low-carbon steel shows that this e.m.f. is proportional to the intensity of magnetization and not to the applied field. For saturation, the e.m.f. is independent of the applied field, and for a varying field a typical hysteresis loop is obtained. J. M. HOUGH

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

10369. Electronic structure of impurities in metals. J. FRIEDEL. *Ann. Phys.* [*Paris*] **9**, 158–202 (*March–April*, 1954) *In French.*

Theoretical. Three different approaches are useful, each for a different type of problem. For studying properties due to the conduction electrons and the valence electrons of the impurity, MO scattering methods are used. The method of Mott (1936) for studying the screening potential round an impurity in a Fermi gas is shown to be equivalent to Born's scattering approximation and to the approximation of "rigid bands," and is extended to finite concentrations of the impurity. Up to high concentrations the screening remains nearly perfect and the Fermi level is little displaced. The Born approximation is dropped for infinite dilution, and better agreement with experiment obtained for the resistivity due to impurities. For studying energies of the inner electrons, in calculations of energies of solution of one metal in another, or of X-ray absorption in which the excited atom is treated as an impurity, valence-bond methods are used. The energy of solution depends mainly on Coulomb interactions, but van der Waals interactions must be included when the solvent is Cu, Ag, Au. The method of ionic states is used for X-ray absorption of light elements, and solution of transition metals. 93 references. J. HAWGOOD

539.11

10370. Electron-electron scattering in alkali metals. E. ABRAHAMS. Letter in *Phys. Rev.*, **95**, 839–40 (*Aug.* 1, 1954).

The interaction is estimated by assuming the electron to move in a potential of the form $V = (1/r) \exp(-r/r_0)$ and taking into account the periodicity of the potential through an effective electron mass. Here r_0 is the screening radius. It is shown by a phase-shift analysis that the scattering is relatively unimportant compared to electron–phonon collisions in the higher temperature region and compared to impurity scattering in the very low temperature region. G. E. BROWN

539.11

10371. Energy gap of germanium-silicon alloys. A. LEVITAS, C. C. WANG AND B. H. ALEXANDER. Letter in *Phys. Rev.*, **95**, 846 (*Aug.* 1, 1954).

Homogeneous samples were prepared and the gap width E_g deduced from resistivity-temperature plots. E_g rises steeply with increasing Si until at 50 at.% Si the value characteristic of Si is attained.

C. A. HOGARTH

539.11

10372. Speculations on the energy band structure of Ge–Si alloys. F. HERMAN. Letter in *Phys. Rev.*, **95**, 847–8 (*Aug.* 1, 1954).

Discusses E, k diagrams for Si and Ge and suggests explanations for the change in energy gap from 0·72 to 0·94 eV in the range 0 to 15 mole % and from 0·94 to 1·2 with different rate of variation from 15% to pure Si. C. A. HOGARTH

539.11

10373. Hyperfine splitting in spin resonance of group V donors in silicon. R. C. FLETCHER, W. A. YAGER, G. L. PEARSON AND F. R. MERRITT. Letter in *Phys. Rev.*, **95**, 844–5 (*Aug.* 1, 1954).

Fourteen clearly resolved resonance lines are found in antimony-doped silicon, six of which are due to Sb^{121} nuclear interaction and eight to the Sb^{123} interaction. Phosphorus and arsenic-doped specimens have also been studied. Satellite lines are observed in the case of arsenic, due probably to forbidden transitions. If the impurity concentration is too high, a single line results and can be attributed to conduction electrons. G. F. J. GARLICK

539.11

10374. Precipitation of impurities at dislocations in heat-treated silicon. S. MAYBURG. Letter in *Phys. Rev.*, **95**, 838–9 (*Aug.* 1, 1954).

On heating above or below 900°C, the conductivity respectively increases or decreases almost reversibly. This is attributed to segregation at dislocations below and dispersal from them above 900°C of n-type impurities. It is significant that 900°C is also the temperature at which plastic deformation in Si first occurs.

A. D. LE CLAIRE

539.11

10375. Order–disorder transitions in A_2BC ternary alloys with the plane square or the body-centered cubic lattice. S. HOSOYA. *J. Phys. Soc. Japan*, **9**, 489–95 (*July–Aug.*, 1954).

The statistics of the ternary alloy A_2BC in the plane square or the b.c.c. lattice is investigated with the same

schematic model as used in the usual theories on binary alloys. The calculation is made at the level of the Bragg–Williams approximation. The behaviour of the system is determined by two quantities $v_1 = V_{CA}/V_{BC}$ and $v_2 = V_{AB}/V_{BC}$ and by the sign of V_{BC}, where $V_{ij} = (\varepsilon_{ii} + \varepsilon_{jj})/2 - \varepsilon_{ij}$. ($i$ and j stand for A, B or C; ε_{ij} is the interaction energy between i- and j-atoms.) Four types of ordered states can appear: A(BC) type, (AB)(AC) type and other two intermediate types. They are all partly ordered states in which the Heusler type is not included, for only two sublattices can be distinguished under the present assumption. Which type appears is determined by v_1, v_2 values. The transition is always of the second kind. The contours of the transition temperature on the v_1–v_2 plane are parabolas, and those of the peak value of the specific heat are a pencil of half infinite straight lines with centre at (3/4, 3/4). The latter contours have a maximum when $V_{BC} = 0$, that is, when the system reduces to the AB binary alloy. The segregation temperatures are calculated, without taking the ordering effect into account, in order to show that the order–disorder transition cannot take place at least for some v_1, v_2 values, being covered by segregation. A.

539.11 : 536.666

The calculation of heats of formation of binary alloys. *See Abstr.* 10148

539.11 : 536.7

10376. The thermodynamic approach to solid structure. V. DANIEL. *Brit. J. appl. Phys.*, **5**, 305–11 (*Sept.*, 1954).

A systematic treatment of the properties of materials can be approached at different levels, in terms of different concepts and variables. Solids consist of particles, and may be described either by molecular variables, referring to the properties of particles, or by molar variables, referring to a large assembly of particles as one whole. In practice we almost always measure molar variables such as weight, temperature, etc., but the physicist usually feels that a true understanding of the physics of solids can be obtained only in terms of molecular concepts and variables. However, an approach in terms of thermodynamics, which uses molar variables, is more fundamental, and more practically useful, than is sometimes realized. It is the purpose of this paper to demonstrate a few of the advantages of thermodynamic methods for the treatment of solids. Examples are given to show that a clear understanding of what is thermodynamically possible can save a good deal of misunderstanding, and that measurement of thermodynamic data in some cases makes it possible to predict properties of materials where other methods are unwieldy or impracticable. A.

MOLECULAR STRUCTURE 539.13

539.13 : 535.37

10377. Theory of emissionless transitions in molecules in solutions. A. S. DAVŸDOV. *Zh. éksper. teor. Fiz.*, **24**, *No.* 4, 397–408 (1953) *In Russian.*

Probabilities are calculated for emissionless transitions of the excitation energy of a molecule into the vibration energy of the atoms of (solid or liquid) solvents, and *vice versa*. It is shown that these probabilities depend on (1) the temperature, (2) the displacement of equilibrium positions of the solvent atoms when the energy state of the molecule undergoes a change, and (3) the way in which wave-functions which determine the state of the molecule in the solution react to the change of co-ordinates of the solvent atoms. The part played by emissionless transitions in the phenomena of luminescence and photoconductivity is stressed. F. LACHMAN

539.13 : 533.7 : 533.15

10378. Molecular structure and related problems. Intermolecular potential as revealed by the study of thermal diffusion of gases. K. HIROTA. *Monogr. Res. Inst. Appl. Elect. Hokkaido Univ.*, *No.* 4, 105–23 (1954).

Detailed discussion of experimental results and their interpretation in terms of the rigid sphere model, the inverse power repulsion model and the Lennard-Jones model. The author also discusses pressure effects and the abnormal behaviour of certain isotopic mixtures. 63 references. E. H. SONDHEIMER

539.132

10379. Tables of integrals useful for the calculations of molecular energies. IV. M. KOTANI, E. ISHIGURO AND K. HIJIKATA. *J. Phys. Soc. Japan*, **9**, 553–7 (*July–Aug.*, 1954).

For Pt III, see Abstr. 643 (1954). Coulomb, exchange, and ionic integrals as well as one-electron integrals involving $2s$ and $2p$ Slater type atomic orbitals have been calculated for homopolar diatomic molecules. This work is the extention of the table in Pt III for $\delta R = 7{\cdot}50$, $8{\cdot}00$ and $8{\cdot}50$. The Coulomb- and one-electron integrals have been calculated up to $11{\cdot}50$. A.

539.132 : 541.57

10380. The molecular orbital theory of chemical valency. XVIII. Localized orbitals in conjugated molecules. P. P. MANNING. *Proc. Roy. Soc. A*, **225**, 244–51 (Aug. 31, 1954).

For Pt XVII, see Abstr. 9483 (1954).

539.132

10381. Wavemechanical determination of some constants of the HF molecule. Z. NÁRAY. *Acta phys. Hungar.*, **3**, *No.* 3–4, 255–62 (1954) *In German.*

The theory of hydrogen-halogens based on the ionic model is brought into a convenient form for an analytical evaluation of the energy of HF. This further allows a theoretical determination of other hydrogen-halogens, giving good agreement with empirical values for dissociation energy, internuclear distance, eigenfrequency and dipole moment. J. JACOBS

539.132

10382. The use of symmetrical coordinates of mixed valence force. W. J. O. THOMAS. *J. Phys. Radium*, **15**, 599–600 (*July–Aug.–Sept.*, 1954) *In French.*

The force constants appearing in the quadratic potential function of formamide have been calculated. The method used is described. The values of the constants for the CO and CN vibrations suggest

that the molecule is not plane, that the CN link has little double bond character and that the CO link is nearly a pure double bond. A. J. TAYLOR

539.132

10383. Enlargement due to the centrifugal force in composite levels separated by *l*-type splitting. H. H. NIELSEN. *J. Phys. Radium*, **15**, 601–3 (*July–Aug.–Sept.*, 1954) *In French.*

Differences of varying sign have been reported in the value of q depending on the quantum number J. For linear molecules a correction term ought to be considered, interpreted as centrifugal distortion. A higher approximation for q is examined and the results are applied to microwave measurements of HCN and DCN. J. JACOBS

539.132

10384. The vibrations CH, CD and CC of the molecule of deutero-substituted ethane CH_2D–CH_2D. R. VAN RIET AND M. DE HEMPTINNE. *Ann. Soc. Sci. Bruxelles I*, **68**, *No.* 1–2, 92–107 (1954) *In French.*

The Raman spectra of gaseous and liquid CH_2D–CH_2D and the Raman spectrum of polarization of the liquid substance are tabulated and compared with the previously-recorded infrared absorption spectra [van Riet and de Hemptinne, *Bull. Acad. Roy. Belgique Cl. Sci.*, **39**, 273 (1953)]. Possible modes of vibration are postulated and the configurations of the ethane and deuteroethane molecules discussed.

G. I. W. LLEWELYN

539.132

10385. Selection rules and frequencies of the skeletal vibrations of long chain polymers in the crystalline state. C. Y. LIANG, G. B. B. M. SUTHERLAND AND S. KRIMM. Letter in *J. chem. Phys.*, **22**, 1468–9 (*Aug.*, 1954).

If the molecular chain is a planar zig-zag, there are 3 N frequencies, but only those can be strong in absorption in which corresponding atoms in each unit cell are in phase. Thus only those for which $\lambda = 2\pi r/p (r = 0, 1 \ldots . p–1)$, where λ is the phase difference between successive atoms, and p the number of atoms of one chain in the unit cell, will be active. Frequencies have been calculated for a few values of p, which agree with experiment.

A. J. TAYLOR

539.132

10386. On the transformation of internal coordinates. E. J. O'REILLY, JR. Letter in *J. chem. Phys.*, **22**, 1471 (*Aug.*, 1954).

The construction of the vibrational secular equation by the Wilson method is conveniently systematized by expressing all internal co-ordinates and their transformations under the group operations explicitly in terms of unit bond vectors. As an example, the transformations of the angles involved in a planar 6-atom V_h system are given. J. HAWGOOD

539.132

10387. On the calculation of vibration constants of nitrous oxide. G. AMAT AND M.-L. GRENIER-BESSON. Letter in *J. Phys. Radium*, **15**, 591–2 (*July–Aug.–Sept.*, 1954) *In French.*

See also Abstr. 10057, 10059 (1954). As recently various new bonds were observed in the N_2O spectrum, it was possible to calculate the vibration constants, whilst taking account of the anharmonic resonance interaction, which exists between the levels 10° O and $0{\cdot}02^\circ$ O, and which causes the levels to split up into resonance multiplets. From these calculated constants the other frequencies were determined and where possible compared with experiment. Some frequencies could not be predicted very precisely owing to approximations contained in the first order anharmonic resonance theory. It is suggested that this theory be made more flexible by the replacement of some constants by parameters depending on quantum numbers. A. J. TAYLOR

539.132 : 535.343.4–15

10388. Experimental contribution to the study of the molecule CD_3–CD_2H. R. VAN RIET, C. COURTOY AND M. DE HEMPTINNE. *Ann. Soc. Sci. Bruxelles I*, **68**, *No.* 1–2, 108–18 (1954) *In French.*

Three infrared absorption bands have been observed in the regions 990–1155 cm^{-1} and 2880–3015 cm^{-1}, of which two are of the perpendicular type and the third band of the parallel type. The rotational structure of these bands is discussed and the infrared absorption results correlated with those previously recorded for the Raman spectrum of liquid and gaseous CD_3–CD_2H [van Riet and de Hemptinne, *Ann. Soc. Sci. Bruxelles, I*, **64**, (1950)].

G. I. W. LLEWELYN

539.132 : 535.343.4–14

10389. Microwave investigation of hindered rotation and inversion of methylamine. K. SHIMODA, T. NISHIKAWA AND T. ITOH. Letter in *J. chem. Phys.*, **22**, 1456 (*Aug.*, 1954).

539.132 : 535.375.5

10390. Theory of splitting of vibrational frequency of OH, conditioned by the tunnel effect. M. A. KOVNER AND V. N. KAPSHTAL'. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **17**, *No.* 5, 561–6. *In Russian.*

Assuming that the doublet observed by Baryshanskaya *et al.* [*Izv. Akad. Nauk SSSR, Ser. Fiz.*, **12**, 573 (1948)] in the Raman spectrum of KH_2PO_4 is due to a splitting of the OH bond vibration into two peaks, due to tunnel effect, the Schrödinger equation for the system O–H . . . O is formulated and solved to provide a basis for calculating the value of the height of the potential barrier and the distance between the positions of minimum energy. The latter is shown to be $0{\cdot}36$ Å for KH_2PO_4, in agreement with Mason's theory [Abstr. 324 (1948)]. R. C. MURRAY

539.132

10391. Molecular structure and related problems. Electronic structure of the π-electron system. S. NAGAKURA. *Monogr. Res. Inst. Appl. Elect. Hokkaido Univ.*, *No.* 4, 17–26 (1954).

Review of recent Japanese theoretical and experimental work on conjugated systems and their interactions with surrounding molecules. 56 references.

J. HAWGOOD

539.132

10392. Molecular structure and related problems. Presumed structures for the activated complex in the electronic theories of organic chemistry. K. HIGASI. *Monogr. Res. Inst. Appl. Elect. Hokkaido Univ.*, *No.* 4, 27–39 (1954).

Critical comparison of different theories of the

electrophilic substitution reaction of aromatic molecules (e.g. nitration of toluene). Wheland's MO and resonance approaches are preferred to those of Coulson (LCAO-polarization) and Ri and Eyring (electrostatic). The frontier electron (Fukui) and electron transfer (Nagakura) theories agree well with experiment on predicting preferred orientations and molecular complex formation. J. HAWGOOD

539.132

10393. Calculation of relative transition probabilities in the electronic spectra of unsaturated hydrocarbons. G. BERTHIER. Letter in *J. Chim. phys.*, **51**, 137–8 (*March*, 1954) *In French.*

Instead of calculating, as usual, transition moments with the use of matrix elements of the q_i operators, one can make use of the matrix elements of the velocity operators. Exact calculations should yield the same results, but approximate estimations might differ. This is investigated in the case of some conjugated hydrocarbons with the use of the LCAO approximation. The values found by the new method agree better with experiment. A. J. TAYLOR

539.132

10394. A study of the metallic model (of polymethine molecules) in three dimensions. S. NIKITINE AND S. G. EL KOMOSS. *J. Chim. phys.*, **51**, 129–32 (*March*, 1954) *In French.*

By supposing that all the bonding electrons in the molecular chain are metallic it is found that the electrons which occupy the lowest energy levels have the characteristics of σ-electrons and that the unsaturated electrons those of π-electrons. The correct distribution of electrons among the σ- and π-orbitals leads to a boundary condition which fixes the radius of the cylindrical potential box containing the electrons. A general expression is derived for the transition probabilities and it is shown that the $\sigma \rightarrow \pi$ transitions are forbidden. A. D. LE CLAIRE

539.132

10395. The electronic energy levels in ethylene. H. SPONER AND P. O. LÖWDIN. *J. Phys. Radium*, **15**, 607–11 (*July–Aug.–Sept.*, 1954) *In French.*

Within the framework of molecular orbital theory (LCAO) the following improvements have been used: (i) the 1*s* electrons of the H and C atoms are not included in their respective nuclei, (ii) self-consistent field functions (with exchange) of the free C atom are used in place of Slater's exponential ones. Energies, as functions of the torsion angle, agree with Mulliken's, except for $^1B_{3u}(V)$ at 12·3 eV. J. JACOBS

539.132

10396. Electronic transitions in the nitrite ion. W. G. TRAWICK AND W. H. EBERHARDT. Letter in *J. chem. Phys.*, **22**, 1462 (*Aug.*, 1954).

The polarized ultraviolet spectrum of single crystals of sodium nitrite was studied at liquid nitrogen temperature. A probable $n_N \rightarrow \pi^*$ transition was found at 3851 Å. This band is absent in compounds where the lone pair electrons of the nitrogen are shared with other atoms. A $\pi \rightarrow \pi^*$ band at 2050 Å was polarized in the ionic plane perpendicular to the C_2 axis. A band at 3000 Å is ascribed to an $n_0 \rightarrow \pi^*$ transition, which involves an electron from a lone pair of oxygen electrons.

A. J. TAYLOR

539.132

10397. Ground and excited electronic states of phosgene. J. DUCHESNE. Letter in *J. chem. Phys.*, **22**, 1464–5 (*Aug.*, 1954).

The force constants are calculated for the vibrational potential functions of the ground and first excited ($n - \pi^*$) states of $COCl_2$. The CO bond is more like that in CO_2 than that in COH_2. The CO and CCl bonds are considerably conjugated, and the anti-bonding π^* orbital strongly delocalized. Compare $CSCl_2$ [Abstr. 3501 (1953), 1539 (1954)].

J. HAWGOOD

539.132

10398. Lower electronic states of the free NH_2 radical. J. HIGUCHI. Letter in *J. chem. Phys.*, **22**, 1467–8 (*Aug.*, 1954).

Theoretical. The LCAO SCF method is used for the $^2B_1$ ground state, and the lower excited states obtained using the same MO's, without configuration interaction. The valence angles obtained are 110° for the $^2B_1$ state and 135–160° for the first excited state $^2A_1$. The transition $^2B_1 - {}^2A_1$ is calculated as 1·8 eV, agreeing fairly well with experiment, but configuration interaction is needed to improve agreement for the $^2B_2$ state. J. HAWGOOD

539.132 : 535.343.4–31

10399. Theory of ultraviolet absorption spectra of iodomethanes. M. A. KOVNER AND YU. P. IRKHIN. *Zh. éksper. teor. Fiz.*, **26**, *No.* 3, 317–22 (1954) *In Russian.*

The method previously used for methane [Abstr. 8630 (1951)] is applied to the calculation of the electron levels in CH_3I, CHI_3 and CI_4. Electron transitions in these molecules are classified into different symmetry groups, and a qualitative interpretation is given of their u.v. absorption spectra.

R. C. MURRAY

539.132

10400. Nuclear quadrupole interaction in sodium chlorate and sodium bromate. J. ITOH AND R. KUSAKA. Note in *J. Phys. Soc. Japan*, **9**, 434–5 (*May–June*, 1954).

In $NaBrO_3$ the $m_{+1/2}$ to $m_{-1/2}$ transitions for Br^{79} are observed in magnetic fields up to 5000 gauss. at 5·80 Mc/s and agree with the theoretical angular dependence [see Abstr. 1164 (1952)]. For $NaClO_3$ the departure of ν from $2\mu H/(hI)$ when the field is $\perp$ to the symmetry axis is $40 \cdot 8 \pm 2$ kc/s at 6 Mc/s if $2\mu H/(hI)$ is obtained from LiCl solutions, in comparison with a calculated 45·6 kc/s; the discrepancy is related to the chemical shift. From the splitting of the nuclear resonance lines of the Na^+ at 5·8 Mc/s and about 5000 gauss., e^2qQ for this atom is 801 ± 8 kc/s in the chlorate and 864 ± 8 kc/s in the bromate. The symmetry axis for Na^+ coincides with that for the halogen. D. H. WHIFFEN

539.132

10401. Relation of nuclear quadrupole couplings to the chemical bond. W. GORDY. Letter in *J. chem. Phys.*, **22**, 1470–1 (*Aug.*, 1954).

No *s* hybridization need be introduced to explain the quadrupole couplings of halogen nuclei [see Abstr. 1123 (1950), 7150 (1951)]. Schatz [Abstr.

5837, 7621 (1954)] applies the usual overlap correction of VB theory, dividing the charge density by $(1 + S^2)$, so increasing the total calculated coupling, assuming pure p orbitals, by this factor; it is suggested that this is incorrect in calculations of potential gradient at the nucleus, as it is energetically easier for the bond charge to migrate from outer regions than from near the nucleus, as implied in Schatz' treatment. J. HAWGOOD

539.132 : 538.222

10402. Measurement of the relaxation times T_1 and T_2 of the free radical diphenyl picryl hydrazyl. R. GABILLARD AND J.-A. MARTIN. *C.R. Acad. Sci. [Paris]* **238**, 2307–9 (*June* 14, 1954) *In French.*

Replacing the steady field of a nuclear resonance apparatus at 28·73 Mc/s by a 50cycle field of 15 gauss. amplitude, electron resonance signals are obtained with diphenyl-picryl-hydrazyl. The zero power line width is 1·3 gauss., whence the spin-spin relaxation time T_2 is $4{\cdot}4\times10^{-8}$ sec. Experiments at high r.f. power lead to a value for T_1, the spin-lattice relaxation time of $6{\cdot}3\times10^{-8}$ sec. D. H. WHIFFEN

539.132 : 538.222

10403. Paramagnetic resonance and delocalization of the electrons in organic compounds. J. UEBERSFELD. Letter in *J. Phys. Radium*, **15**, 589–90 (*July–Aug.–Sept.*, 1954) *In French.*

Points out that the Hamiltonian for the hyperfine structure of interaction of an electron with nuclear moments in paramagnetic resonance leads to information about the delocalization of electrons.

D. H. WHIFFEN

539.132

10404. Configuration interaction in self-consistent butadiene. A. PULLMAN. *J. Chim. phys.*, **51**, 188–96 (*April*, 1954) *In French.*

The self-consistent LCAO MO's of Parr and Mulliken [Abstr. 1215 (1951)] are used in a full configuration/interaction (CI) treatment of the 9 lowest ^1A_g states, the 7 ^3Ag, 8 ^1B_u and 8 ^3B_u states of *s-trans* butadiene. All multicentre integrals are included. In the ground state, E_0, the energy is depressed by 2·2 eV, but the charge distribution scarcely affected ($\sim 0{\cdot}3\%$); the important contributions to the wave-function are made by two doubly excited states, one 11 eV above E_0 before CI, and the other, the highest of the 9 states interacting, 23 eV above E_0. The agreement with experiment for the N–V_1 transition is actually made worse by CI. Calculations of the oscillator strengths by the usual formula $\int\psi_A^* z\psi_B d\tau$ and by the more correct $\int\psi_A^*$ grad $\psi_B d\tau$ not only give widely different results, but are oppositely affected by CI, agreement with experiment being made worse for the correct formula. It is concluded that the only improvement on the SCF MO results made by CI is in the ground-state energy, a change perhaps more sensibly made by the semi-empirical revaluation of monocentre integrals suggested by Pariser and Parr [Abstr. 3508, 4261 (1953)].

J. HAWGOOD

539.132 : 535.33

Quantum faults in the molecular Rydberg series. *See Abstr.* 10015

539.132 : 535.375.5

10405. Studies on molecular structure by the Raman effect. S. BHAGAVANTAM. *J. Phys. Radium*, **15**, 513–14 (*June*, 1954) *In French.*

The correlation between formation of hydrogen bonds in aldehydes and ketones and the Raman spectra of these compounds is discussed.

G. I. W. LLEWELYN

539.132 : 539.133 : 541.4

10406. Bond angle, dipole moment, and base strength. J. H. GIBBS. Letter in *J. chem. Phys.*, **22**, 1460–1 (*Aug.*, 1954).

These properties of the hydrides and methyl and phenyl compounds of the V, VI and VII group elements have been shown by LCAO calculations to be related through hybridization to lone pair orbitals. The lone pair moment, being governed by the size of the AO's and the degree of hybridization, increases with increasing Z until decrease of hybridization overcomes this increase, the maximum being at period 2 for the organic compounds, and at period 1 for hydrides. The base strength differences are governed by the energy needed for promotion to complete tetrahedral hybridization. J. HAWGOOD

539.132

10407. Simultaneous calculation of polarizability and electronic transition energy of molecules. Special case of ethylene and benzene. J. BARRIOL AND J. RÉGNIER. *J. Phys. Radium*, **15**, 528–30 (*June*, 1954) *In French.*

The general problem of polarizability by the variation method is discussed. It is shown that α is insensitive to the choice of wave-functions. For a corrected Heitler-London wave-function α and the excited state energy are determined for C_2H_4. A later paper will compare with antisymmetrized MO results. J. JACOBS

539.132 : 541.5

10408. Influence of hybridization and bond length on bond polarizability. S. RÉGNIER AND J. RÉGNIER. *J. Chim. phys.*, **51**, 181–3 (*April*, 1954) *In French.*

The polarizability of the C–C σ-bond depends on the hybridization of the AO's involved. A variational calculation shows that the tetrahedral AO's in C_2H_6 lead to a σ-bond polarizability of 1·50, and the trigonal AO's in C_2H_4 to one of 1·58. The empirical value is 1·62. The influence of bond length seems small, while that of Z is more important.

J. HAWGOOD

539.132

10409. A method of determining the dissociation energy of nitrogen. W. F. SHEEHAN, JR. Letter in *J. chem. Phys.*, **22**, 1461 (*Aug.*, 1954).

The proposed method would distinguish between previously proposed values of $D_0(N_2)$ by determining whether interaction of a non-equilibrium isotopic mixture of N_2 with either Kr or Xe in their lowest excited states produced dissociation. For example, if Kr but not Xe produced dissociation, the value of 9·76 eV for the dissociation limit would be confirmed.

J. HAWGOOD

539.133

10410. Molecular structure and related problems. The molecular structure of tropolone. M. KUBO, Y. KURITA AND M. KIMURA. *Monogr. Res. Inst. Appl. Elect. Hokkaido Univ., No.* 4, 1–15 (1954).

A review of results of recent physico-chemical and theoretical investigations, mainly Japanese, of troponoid compounds, with particular reference to dipole moments, X-ray and electron diffraction and vibrational spectra. 40 refs. J. HAWGOOD

539.133

10411. Geometry of VIX_4 molecules. F. LACHMAN. Letter in *J. chem. Phys.*, **22**, 1459–60 (*Aug.*, 1954).

Discusses bond angles, hybridization and symmetry groups of the possible arrangements of molecules with co-ordination number four, comparing with experimental data on Se and Te tetrahalides, Se diphenyl dihalides, $IO_2F_6^-$ and CrO_2Cl_2. Most of these have the "$TeCl_4$ structure" [Syrkin and Dyatkina (1950)], with C_{2v} symmetry, not envisaged by Kimball (1940). J. HAWGOOD

539.133 : 537.226.3

10412. Ellipsoidal molecular shape and dielectric relaxation-analysis. J. P. POLEY. Letter in *J. chem. Phys.*, **22**, 1466 (*Aug.*, 1954).

Using an Onsager type field with ellipsoidal molecules graphs of ε' against ε'' are shown to be almost semi-circular. D. H. WHIFFEN

539.133

10413. Determination of the structure of halogenated silanes by ultra-short-waves. B. BAK, J. BRUHN AND J. RASTRUP-ANDERSEN. *J. Phys. Radium*, **15**, 515–16 (*June*, 1954) *In French.*

A review of published angles and distances from microwave and electron diffraction measurements. D. H. WHIFFEN

539.133

10414. Must the sulphur bridge be considered as a conjugation conductor? A. MANGINI AND R. PASSERINI. *J. Phys. Radium*, **15**, 625–6 (*July–Aug.–Sept.*, 1954) *In French.*

Sulphur can act as an electron donor, acceptor or even donor-acceptor. In diaryl sulphides various electronic structures should be included in the ground state with different arrangements of the S electrons. This is true for various other compounds, but no bathochromic shift is found in the spectrum of e.g. *o*- or *p*-nitrodiphenylsulphide, or these compounds substituted with groups like OCH_3, OH or NH_2, where one would expect this shift if both phenyl groups were conjugated. This might be due to the non-polarity of the molecule, so some dibenzothiophenes, substituted with NH_2 and NO_2 at various positions were also investigated. Here a large bathochromic shift was found if both groups were situated *para* to those C atoms connecting the benzene rings, but not when *para* to the C atoms attached to the sulphur. In all these cases no conjugation caused by the S atom can be inferred. A. J. TAYLOR

539.133

10415. On the transition temperature of molecular rotation in long-chain compounds with the discontinuous model. S. HOSOYA. *J. Phys. Soc. Japan*, **9**, 524–30 (*July–Aug.*, 1954).

The rotational transition, which is found in some long-chain compounds, is discussed at the level of Bethe's approximation, assuming that the rigid molecules occupy the rigid two-dimensional triangular lattice points, and that they can take only three orientations around their axes. Four kinds of interaction energies must be considered. Calculations are made concerning what values of interaction energies make the transition to the paraffin-type arrangement possible, and how the transition temperature depends on these energy values. Some reasonable results are obtained. At the same time, another type of the ordered arrangement is also investigated, in which all molecules take the same orientation. A.

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.152.1

10416. Excitation of nuclear rotational states by the electric field of impinging particles. T. HUUS AND C. ZUPANČIČ. *K. Danske Vidensk. Selsk., mat-fys. Medd.*, **28**, *No.* 1, 19 *pp.* (1953).

When heavy nuclei are bombarded with charged particles with an energy appreciably below the Coulomb barrier, the short-range nuclear forces cannot operate. The collisions may, however, still give rise to nuclear excitations produced by the electric field of the impinging particles. According to the nuclear model of Bohr and Mattelson which describes the dynamics of the nucleus in terms of the coupled motion of individual particles and surface oscillations, low-lying excited states of a collective type are expected for nuclei possessing large quadrupole moments. These states should exhibit a rotational spectrum and should have relatively large cross-sections for Coulomb excitation. An investigation was made of the Coulomb excitation effects produced by protons of energies up to 2 MeV on tantalum and tungsten targets. The excitation was detected by the γ-rays emitted on de-excitation, the number and energy of these γ-rays emitted at various angles with respect to the beam was found using a scintillation counter. In tantalum evidence for two rotational levels was obtained, the first at 137 keV, the second, at 300 keV, in agreement with theoretically predicted ratio between the energies of the first two states. The energy dependence of the cross-sections and the angular distribution of the 137 keV radiation, which was isotropic, were also found to agree with theory. In tungsten, evidence for one state at about 115 keV was found. In both elements the quadrupole moments deduced from the measured cross-sections are of the same magnitude as those derived from spectroscopic evidence and measured lifetime. D. R. CHICK

539.152.1

10417. A simple graphical determination of the eigenvalues of a 3-dimensional square-well potential with spin-orbit coupling. (On the shell model of nuclei.) K. WOESTE. *Z. Phys.*, **138**, *No.* 1, 105–8 (1954) *In German.*

The solution concerns a finite depth square-well with a δ-type spin-orbit interaction at the surface,

and takes the form of two families of curves (one to be drawn on tracing paper) which are displaced relative to one another by amounts corresponding to the well parameters and the magnitude of the coupling. The points of intersection give the eigenvalues.

W. J. SWIATECKI

539.152.1

10418. Application of the Fermi–Thomas method to internal nuclear vibrations. S. G. RIZHANOV. *Zh. éksper. teor. Fiz.*, **26**, *No.* 3, 264–9 (1954) *In Russian.*

Hydrodynamical techniques are used to describe density fluctuations in the nucleus. The equation of state is obtained from Fermi–Thomas statistics. In zero-order approximation the density is taken as constant over a sphere and the equations are dealt with for first-order variations in density of dipole and quadripole types. Surface vibrations are treated briefly. G. E. BROWN

539.152.1

10419. Self-consistent field equation for the nucleons inclusive of electromagnetic force. A. S. KOMPANEETS. *Zh. éksper. teor. Fiz.*, **26**, *No.* 2, 153–8 (1954) *In Russian.*

A quasi-classical equation on the density-matrix (which is equivalent to $[H, \rho] = 0$ (where the [ ]'s denote classical Poisson brackets) is obtained as zero-order approximation to a quantum equation on the density. It is shown that the classical approximation to this equation can be expected to be valid in the description of the charge distribution in heavy nuclei. Such an approximate equation is obtained for the neutron and proton components of the nuclear charge density. G. E. BROWN

539.152.1

10420. Coulomb radius constant from nuclear masses. A. E. S. GREEN. *Phys. Rev.*, **95**, 1006–9 (*Aug.* 15, 1954).

On the assumption of a uniform charge distribution, the Coulomb energy constant obtained from a recent adjustment of the semi-empirical formula to the mass data corresponds to the Coulomb radius constant $1{\cdot}237$ (in 10^{-13} cm). This result is in good agreement with the radius constant obtained from recent studies of μ-mesonic X-rays, and can be readily reconciled with the radii obtained from electron scattering, isotope shift measurements, and mirror nuclide mass differences. In view of the importance of the question of the Coulomb radius an attempt is made to refine the determination of the Coulomb radius constant based upon nuclear masses by using an objective criterion for best fit. A least-squares analysis involving a new adjustment procedure yields the radius constant $1{\cdot}216$. An investigation of the precision of this determination leads to the assignment of a probable error of 1%. This new radius constant agrees with the average radius constant obtained from μ-mesonic X-rays within the small probable error assigned to each. A.

539.152.1

10421. Nuclear radii from inelastic cross-section measurements. G. P. MILLBURN, W. BIRNBAUM, W. E. CRANDALL AND L. SCHECTER. *Phys. Rev.*, **95**, 1268–78 (*Sept.* 1, 1954).

Inelastic cross-sections for high-energy protons, deuterons, He^3 particles, and α-particles accelerated in the 184 in. cyclotron were measured by an attenuation technique. All the cross-sections vary as the square of the nuclear radius and indicate that if the nucleus has a fringe it increases as $A^{\frac{1}{3}}$. The derived value of the nuclear radius constant a_0 depends on the nuclear model and the particular bombarding particle. The effect of the nucleus is found to extend at least to a radius given by $a_0 = (1{\cdot}68 \pm 0{\cdot}04) \times 10^{-13}$ cm. Deuteron stripping cross-sections were derived and found to vary approximately as the square root of the mass number. A.

539.152.1

10422. Nuclear cross sections and the size of the nucleus. W. HECKROTTE. *Phys. Rev.*, **95**, 1279–81 (*Sept.* 1, 1954).

The recent experiments on the total inelastic cross-sections for 190 MeV deuterons on various target nuclei demand a considerably larger nuclear radius than is usually accepted to explain the experimental results. It is shown that this result is not inconsistent with the total nuclear cross-sections for 90 MeV neutrons if a nonsquare-well nuclear shape is taken. Taking for numerical simplicity a parabolic shape, the radius (measured to the edge of the distribution) that is obtained is $R = 1{\cdot}6A^{\frac{1}{3}} \times 10^{-13}$ cm. The average radius is $R = 1{\cdot}0A^{\frac{1}{3}} \times 10^{-13}$ cm. This result is compared with other determinations of the nuclear radius. A.

539.152.1 : 539.18

Scattering of μ-mesons and charge distribution in atomic nuclei. *See Abstr.* 10535

539.152.2

10423. On the application of a simple magnetic resonance absorption device for quantitative measurements. P. S. FARAGÓ, M. GÉCS AND J. MERTZ. *Acta. phys. Hungar.*, **3**, *No.* 3–4, 329–33 (1954).

A specially simple nuclear resonance detector is obtained if the sample is in the resonant circuit of an oscillator and the power output is observed as a function of magnetic field. The linearity of change of output with χ'' is demonstrated. D. H. WHIFFEN

539.152.2

10424. The Sachs exchange moment. R. H. DALITZ. *Phys. Rev.*, **95**, 799–800 (*Aug.* 1, 1954).

A derivation of the Sachs exchange moment [Abstr. 3862 (1948)] is given which clearly shows how this exchange moment is uniquely determined by the exchange potential. The relation between this and the treatments of Sachs [Abstr. 4095–6 (1952)] and of Osborne and Foldy [Abstr. 85 (1951), 1718 (1954)] is discussed. A.

539.152.2

10425. Nuclear deformation and the moment of inertia of nuclear rotational states. K. W. FORD. *Phys. Rev.*, **95**, 1250–2 (*Sept.* 1, 1954).

Evidence concerning nuclear deformation from isotope shifts and from rotational states in even-even nuclei is compared for nuclei near neutron number 82. It is concluded that the moment of inertia of the rotational states is 4 ± 1 times greater than the theory predicts, if the nuclear radius is $1{\cdot}20 \times 10^{-13} A^{\frac{1}{3}}$ cm, and if the interpretation of isotope shifts in terms of nuclear deformation is correct. A.

539.152.2

10426. Reorientation of aligned nuclei. N. R. STEENBERG. *Phys. Rev.*, **95**, 982–8 (*Aug.* 15, 1954).

Where nuclei aligned at low temperatures decay by a two-stage cascade, the degree of alignment of the intermediate state may be influenced by magnetic coupling. If the second stage is γ-radiation, the angular distribution will be influenced as a consequence. This effect is treated by assuming a static interaction and twofold ionic degeneracy. In particular for high temperatures very explicit results are given for Δ', the mean degree of alignment of the intermediate state. This is dependent primarily on the mean life and magnetic moment of the intermediate state. It is found that if the properties of the intermediate state are similar to those of the initial state: (1) reorientation effects will be present if $\tau > 10^{-9}$ sec; (2) they may either increase or decrease Δ'; (3) a strong external field cancels the effect altogether; (4) reorientation can introduce $\cos^4\theta$ terms into the angular distribution even at the highest temperatures; (5) where τ is very long, Δ' tends to a finite limit. The calculations are applied to an experiment. A.

539.152.2 : 536.48

10427. Magnetic resonance of oriented nuclei. G.-J. BÉNÉ, P.-M. DENIS AND R.-C. EXTERMANN. *Arch. Sci.* [*Geneva*] **6**, *No.* 5, 284–6 (1953) *In French.*

A brief account of ways in which the anisotropy of radioactive emission of nuclei oriented through their spin interactions and quadrupole moments, can be used as a thermometer below 0·01°K. D. H. WHIFFEN

539.152.2 : 536.48

10428. Polarization of Mn^{55} nuclei: cryogenic aspects. J. W. T. DABBS AND L. D. ROBERTS. *Phys. Rev.*, **95**, 970–4 (*Aug.* 15, 1954).

A brief discussion of certain cryogenic aspects of nuclear polarization is given. This discussion is applied to Mn^{55} in the paramagnetic salt $Mn(ND_4)_2(SO_4)_2.6D_2O$. Measurements on this salt of the temperature in the range $0{\cdot}12° \leqslant T \leqslant 0{\cdot}35°K$ and of magnetic moment up to 90% of saturation as a function of magnetic field in the range $660 \leqslant H \leqslant 4560$ gauss and for an entropy $S/R = 0{\cdot}514$ are described. These measurements are used to calculate the nuclear polarization as a function of field in this magnetic field range and at this entropy, and they form the cryogenic basis for Mn^{55} polarization experiments reported previously. A.

539.153

10429. On the calculation of the polarizability of the 2*p* atomic orbitals. J. TILLIEU AND J. GUY. *C.R. Acad. Sci.* [*Paris*] **238**, 2498–500 (*June* 28, 1954) *In French.*

The rigorous solution for the polarizability in the *Ox* and *Oy* directions was $\alpha_x(2p_z) = \alpha_y(2p_z) = 39/(4c^4)$ and an approximate method gave for that in the *Oz* direction $\alpha_z(2p_z) = 1546/(16c^4)$, with $\psi(2p_z) = (c^5/\pi)^{\frac{1}{2}}\ \rho\cos\theta e^{-c\rho}$. J. HUGHES

539.153

10430. Relativistic and magnetic spin interactions in helium-like atoms. J. SUCHER AND H. M. FOLEY. *Phys. Rev.*, **95**, 966–9 (*Aug.* 15, 1954).

Relativistic and magnetic spin corrections to the ionization energy of He and O^{6+} are given. The magnetic spin interaction given by Sessler and Foley has been derived by a careful evaluation of the Breit operator. The relativistic corrections obtained by reduction of the Dirac equation differ from some previous expressions. With all known corrections taken into account, there remains a discrepancy with experiment of about 30 cm^{-1} in the case of He. Within the rather large experimental and theoretical uncertainties, there appears to be no residual discrepancy in the case of O^{6+}. A.

539.153 : 537.564

Ionizing collisions and the dipole strength of optical transitions. *See Abstr.* 10291

539.153.4

10431. Theory of localizability of corpuscles. I. The concept of "box" and the geometrical significance of the shell concept in the electrons surrounding atoms. R. DAUDEL, S. ODIOT AND H. BRION. *J. Chim. phys.*, **51**, 74–7 (*Feb.*, 1954) *In French.*

It is shown how the regions of space associated with each shell of an atom (e.g. He) split into smaller ones, boxes, where a high probability exists of finding an electron with given spin. The lowest triplet state contains one *K*, one *L* electron; the box is a sphere whose interior corresponds to the *K* shell, exterior to the *L* one. For the 2nd triplet state the best splitting-up is not spherical but planar, with 2 *L* electrons. J. JACOBS

539.155.2

10432. Determination of isotopic composition of water by measurement of infrared absorption. J. LECOMTE, M. CECCALDI AND E. ROTH. *J. Phys. Radium*, **15**, 543–4 (*June*, 1954) *In French.*

A method of determining the isotopic composition of water by examination of the infrared absorption spectrum is described. For samples containing a high percentage of D_2O the determination is carried out in the region of 3500 cm^{-1}, the thickness of the sample being several tenths of a millimetre. For samples containing a moderate percentage of D_2O the absorption is measured at 1666 μ, and for very small D_2O contents at about 2500 cm^{-1}. A. J. MEE

539.155.2

10433. On a phenomenon of isotope separation caused by the passage of an electric current through a molten metal. G. NIEF AND E. ROTH. *C.R. Acad. Sci.* [*Paris*] **239**, 162–4 (*July* 12, 1954) *In French.*

This phenomenon has been observed by Haeffner in mercury [Abstr. 3772 (1954)], and here the same experiment is carried out on molten gallium. After the current had passed for some days it was stopped and the metal allowed to solidify. It showed a non-uniform composition when examined with a mass spectrometer. A. J. TAYLOR

539.155.2 : 541.127

10434. Chlorine isotope effect. R. M. BARTHOLOMEW, F. BROWN AND M. LOUNSBURY. Letter in *Nature* [*London*] **174**, 133 (*July* 17, 1954).

Tert.-butyl chloride was allowed to react with $AgNO_3$ in 98% ethyl alcohol at room temperature, and it was found that the compound containing Cl^{35} reacted more quickly than that containing Cl^{37}. A. J. MEE

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16.08

10435. Self-absorption correction in carbon-14 counting. E. K. GORA AND F. C. HICKEY. *Analyt. Chem.*, **26**, 1158–61 (*July*, 1954).

The necessity for correcting for self-absorption if solid or liquid samples are used imposes a serious restriction on the accuracy of all tracer experiments involving weak β-emitters. The present work was undertaken with the intention of improving the method of making such corrections. An equation was derived for the relative specific activity as a function of the geometry of the counting arrangement, the mass absorption coefficient, k, and the sample thickness, x (mass per sample area exposed to the counter). Comparison of experimental data obtained in different geometries with the self-absorption curves given by this equation permits a fairly accurate estimate of k. Once the geometry and the mass absorption coefficient are known the specific activities can be corrected to infinite thinness. Satisfactory correspondence between theory and experimental results is obtained, even though the influence of back-scattering and self-scattering is neglected. A.

539.16.08

10436. Application of nuclear photographic plates to the measurement of the radioactivity of liquids. R. COPPENS. Letter in *J. Phys. Radium*, **15**, 588–9 (*July–Aug.–Sept.*, 1954) *In French.*

A protective layer of celluloid of about 10 μ thickness coated on a nuclear emulsion enables the emulsion to be placed into a radioactive solution without loss of sensitivity. The layer can easily be stripped before developing the emulsion. A. C. COATES

539.16.08 : 778.34

10437. Application of the capillary tube method to the determination of radiocarbon. M. REINHARZ AND G. VANDERHAEGHE. *Nuovo Cimento*, **12**, 243–9 (*Aug.*, 1954).

An application of the capillary tube method to the determination of radiocarbon in liquids or dissolved substances is described. The absolute sensitivity of the method has been found to be of the order of 10^{-15} curie per cm tube-length. The high sensitivity is useful when only very small amounts of a feebly active substance are available. A.

539.163

10438. Contribution to the study of Th C and Th C′ sources. M. ADER. Letter in *J. Phys. Radium*, **15**, 583 (*July–Aug.–Sept.*, 1954) *In French.*

Further studies on the long-range particles from thorium [Abstr. 7672, 7674 (1954)] tend to confirm that these particles arise from the spontaneous fission of the nuclei of an element in the thorium series.

L. E. MUSSELL

539.163 : 539.165

10439. Natural radioactivity of rhenium. A. D. SUTTLE, JR AND W. F. LIBBY. Letter in *Phys. Rev.*, **95**, 866–7 (*Aug.* 1, 1954).

A re-examination of the β-radiation of rhenium in a screen-wall counter gave an upper limit of 8 keV for E_{max} [cf. earlier value of 43 keV, Abstr. 1898 (1948)], and a $\frac{1}{2}$-life $\leqslant 10^{11}$ yr. Attempts to incorporate Re into a proportional counter as a gaseous compound were not successful. A. O. STANESBY

539.163.1

10440. The spontaneous fission rate of ^{240}Pu. F. R. BARCLAY, W. GALBRAITH, K. M. GLOVER, G. R. HALL AND W. J. WHITEHOUSE. Letter in *Proc. Phys. Soc.* [*London*] *A*, **67**, 646–8 (1954).

A weighted mean of $(1{\cdot}62 \pm 0{\cdot}04) \times 10^6$ fissions $g^{-1}.hr^{-1}$ was obtained from measurements on 2 samples. A. O. STANESBY

539.163.1

10441. Half-life of thallium-204. D. L. HORROCKS AND A. F. VOIGT. *Phys. Rev.*, **95**, 1205 (*Sept.* 1, 1954).

A determination of the half-life of Tl^{204}, based on measurements over a 3-year period, gave a value of $4{\cdot}1 \pm 0{\cdot}1$ years. A.

539.163.1

10442. Natural radioactivity of Sm^{147}. G. BEARD AND M. L. WIEDENBECK. *Phys. Rev.*, **95**, 1245–6 (*Sept.* 1, 1954).

The half-life of Sm^{147} has been measured to be $1{\cdot}25 \pm 0{\cdot}06 \times 10^{11}$ years with an energy distribution corresponding to the emission of monoenergetic α-particles. A.

539.163.2

10443. The decay of Bi^{207}. A. H. WAPSTRA. *Ark. Fys.*, **7**, *Paper* 22, 279–87 (1953).

Bi^{207} decays by electron capture, 80% of the decays leading to a 0·9 sec isomeric state in Pb^{207} which de-excites by the successive emission of a 1060 keV and a 565 keV γ-ray, and 20% to the 565 keV level. The total decay energy is 2050 keV. The Auger conversion probability for lead is $0{\cdot}043 \pm 0{\cdot}015$. A.

539.163.2

10444. Contribution to the study of the disintegration scheme of Sm^{153}. N. MARTY. *C.R. Acad. Sci.* [*Paris*] **238**, 2516–18 (*June* 28, 1954) *In French.*

The β- and γ-spectra were examined using a Slätis–Siegbahn β-spectrometer and a scintillation spectrometer. The relative intensities of the partial β-spectra of E_{max} 690 and 620 keV were 0·45 : 0·55; and of the 545 and 103 keV γ-rays 0·007–0·01; the 172 keV γ-ray was confirmed (intensity $< 0{\cdot}02$ of 103 keV γ-ray); an internally-converted γ-radiation of 84 keV, produced by Coulomb excitation of Eu^{153}, was also found. A. O. STANESBY

539.163.2 : 539.152.1

10445. The nuclide Al^{28} and the magic number 14. M. E. NAHMIAS. *J. Phys. Radium*, **15**, 568–70 (*July–Aug.–Sept.*, 1954) *In French.*

The total disintegration energy of Al^{28} was measured as $4{\cdot}58 \pm 0{\cdot}15$ MeV, showing an anomaly of $\sim 1{\cdot}5$ MeV compared with neighbouring nuclides of the same isotopic spin, in partial agreement with the shell-model theory. A. O. STANESBY

539.163.2 : 539.152.1

10446. The nuclide Al^{29} and the magic number 14. M. E. NAHMIAS AND A. H. WAPSTRA. *J. Phys. Radium*, **15**, 570–2 (*July–Aug.–Sept.*, 1954) *In French.*

The total disintegration of Al^{29} was measured as $3{\cdot}97 \pm 0{\cdot}15$ MeV, showing an anomaly of ~ 2 MeV

compared with neighbouring nuclides of the same isotopic spin, in partial agreement with the shell-model theory. A. O. STANESBY

539.163.2 : 539.152.1

10447. The total disintegration energy of the nuclide Na^{25} and the magic number 14. M. E. NAHMIAS AND T. YUASA. *C.R. Acad. Sci.* [*Paris*] **239,** 47–9 (*July* 5, 1954) *In French.*

The β- and γ-spectra were investigated using a NaI(Tl) scintillation counter. The β-spectrum has 2 components with E_{max} $3{\cdot}65 \pm 0{\cdot}25$ and $3 \pm 0{\cdot}25$ MeV (intensity $\sim 0{\cdot}5$), and there is a γ-ray of 625 ± 25 keV. There is no evidence of any anomalous energy deficiency in Na^{25} corresponding to a closed sub-shell of 14 neutrons. A. O. STANESBY

539.165 : 537.533.35

The disintegration of Mg^{27}. *See Abstr.* 10249

539.165 : 539.166

10448. The energy of the first excited state of $_{36}Kr^{80}$. J. LABERRIGUE-FROLOW AND N. MARTY. Letter in *J. Phys. Radium,* **15,** 584–5 (*July–Aug.–Sept.,* 1954) *In French.*

β-spectrum and β-γ-coincidence measurements gave the max. energies of the partial β-spectra as 2 (intensity $0{\cdot}85$) and $1{\cdot}38$ MeV ($0{\cdot}15$) with the energy of the 1st excited state 620 keV. A. O. STANESBY

539.165 : 539.166.83

10449. On the decay of Hg^{203}. S. THULIN AND K. NYBÖ. *Ark. Fys.,* **7,** *Paper* 22, 289–91 (1953).

The maximum energy of the Hg^{203} β-continuum is found to be 210 ± 2 keV. The K internal-conversion coefficient of the 279 keV γ-ray is $0{\cdot}154 \pm 0{\cdot}015$ and the $K/(L + M)$ ratio is $2{\cdot}8 \pm 0{\cdot}2$. A.

539.165 : 539.166.83

10450. K-Auger electrons from Ba 137. T. AZUMA. *J. Phys. Soc. Japan,* **9,** 443–6 (*July–Aug.,* 1954).

K-Auger electrons ejected from the L and M levels were studied by means of a double-coil, magnetic-lens β-ray spectrometer with thin Zapon film G.M. counter. The kinetic energies of those electrons observed were compared with the values calculated by Slater's system of screening constants. The relative intensities K–LL : K–LM : K–MN are estimated to be $10 : 5{\cdot}0 \pm 0{\cdot}2 : 0{\cdot}8 \pm 0{\cdot}04$ and the K fluorescence yield ω_K, $0{\cdot}85 \pm 0{\cdot}03$. A.

539.165 : 539.166.83

10451. Internal bremsstrahlung. R. E. CUTKOSKY. *Phys. Rev.,* **95,** 1222–5 (*Sept.* 1, 1954).

Some theorems are given which apply to the β-radiation and internal bremsstrahlung emitted by light nuclei. Use of these theorems simplifies the calculation of approximate spectra and angular correlations. The principal new result is a simple, explicit relation between the spectra and angular correlations of the internal bremsstrahlung of K-capture and the spectra and angular correlations of positrons. A.

539.165.08

10452. Isotopic estimation by the gold absorption method. M. FORRO. *Z. Phys.,* **138,** *No.* 3–4, 441–8 (1954) *In German.*

An elaboration of Abstr. 1642 (1954) with application to the qualitative and quantitative determination of isotopic mixtures. A. O. STANESBY

539.165.08

10453. A note on avoiding scattered electrons from the spectrum obtained by magnetic spectrometer. M. SAKAI. Note in *J. Phys. Soc. Japan,* **9,** 437–8 (*May–June,* 1954).

Improved resolution can be obtained by making spectrum measurements with a scintillation counter, biased so as to cut out small pulses due to scattered electrons, instead of with a G.M. counter.

P. ROTHWELL

539.165.08 : 537.533.35

A β-spectrometer with a magnetic prism and a magnetic lens. *See Abstr.* 10250

539.165.2

10454. On the shape of first forbidden β-spectra. J. LABERRIGUE-FROLOW AND R. NATAF. *J. Phys. Radium,* **15,** 438–44 (*June,* 1954) *In French.*

The correction to allowed β^-- and β^+-spectra for 1st forbidden transitions ($\Delta J = 1$, yes) was calculated for pure tensor (T) interaction for $Z = 5$, 35 and 50, $E_{max} = 0{\cdot}25$, $0{\cdot}5$ ($0{\cdot}5$) $3{\cdot}0$ MeV; the corrections are relatively small. Values are also given which enable the calculation of the correction for any given interaction, particularly mixed scalar and tensor (S, T).

A. O. STANESBY

539.166

10455. On the continuous γ-radiation associated with the K-capture of Ge^{71}. M. LANGEVIN. *C.R. Acad. Sci.* [*Paris*] **238,** 2518–20 (*June* 28, 1954) *In French.*

This was studied using a NaI(Tl) scintillation spectrometer. The energy of the transition was 237 ± 5 keV; evidence was also found for a second K-capture transition of 170 ± 10 keV and $\frac{1}{2}$-life $13{\cdot}2 \pm 0{\cdot}2$ days. A. O. STANESBY

539.166

10456. Gamma transitions in W^{182}. F. BOEHM, P. MARMIER AND J. W. M. DUMOND. Letter in *Phys. Rev.,* **95,** 864–5 (*Aug.* 1, 1954).

Precision β-ray spectrometer and curved-crystal γ-ray spectrometer measurements are reported. A decay scheme including multipolarity assignments, is presented. J. J. WILKINS

539.166

10457. Build-up measurements on cobalt-60 gamma radiation in iron and lead. C. GARRETT AND G. N. WHYTE. *Phys. Rev.,* **95,** 889–91 (*Aug.* 15, 1954).

The transmission of γ-radiation from a "point isotropic" source of cobalt-60 through iron and lead has been measured out to a thickness of approximately 15 mean-free-paths. The dose build-up factors derived from the observed transmissions agree satisfactorily with calculations. A.

539.166

10458. Observations on the 4·43-MeV gamma rays from C^{12}. W. R. MILLS, JR AND R. J. MACKIN, JR. *Phys. Rev.,* **95,** 1206–8 (*Sept.* 1, 1954).

A scintillation spectrometer has been used for "fore and aft" measurements to demonstrate that the 4·43 MeV γ-radiation from $Be^9(\alpha,n\gamma)C^{12}$ exhibits a Doppler shift as the result of motion of the emitting nucleus. This implies a lifetime for the C^{12} excited state less than 3×10^{-13} sec. The Compton electron spectrum from a thin convertor has been studied in a

magnetic lens spectrometer to produce a value for the level excitation of $4{\cdot}425 \pm 0{\cdot}020$ MeV. The spectrum of internal pairs has been found to agree most closely (to 5%) with the (known) assignment of the radiation as electric quadrupole. A.

539.166

10459. Gamma-ray spectrum of Ac^{228}. H. C. Box and G. S. Klaiber. *Phys. Rev.*, **95**, 1247–9 (*Sept.* 1, 1954).

The γ-radiation from a radioactively pure source of Ac^{228} has been studied using a NaI scintillation spectrometer. Gamma rays of 0·098, 0·127, 0·336, 0·410, 0·458, 0·907, 0·965, 1·587, 0·155, 0·220, 0·278 and 0·790 MeV are indicated, of which the last four are previously unreported. A double scintillation spectrometer is described which was used to investigate γ–γ coincidences. A decay scheme for Ac^{228} is suggested. A.

539.166 : 537.531

10460. Study of the γ- and X-radiation emitted by Pa^{231}. A. Mouhasseb and M. Riou. *C.R. Acad. Sci.* [*Paris*] **238**, 2520–2 (*June* 28, 1954) *In French.*

This was examined using a NaI(Tl) scintillation counter and the energies and relative intensities obtained: 15 keV (Ac *L* X-radiation), intensity 15–20; 27, $5 \pm 0{\cdot}5$; 48 ± 5, $0{\cdot}23 \pm 0{\cdot}05$; 95 ± 3 (Ac *K* X-radiation), 1; and 295 ± 5 (complex), 5 ± 1. A. O. Stanesby

539.166 : 539.163.2

10461. The decay of Xe^{129m}. S. Thulin. *Ark. Fys.*, **7**, *Paper* 22, 269–73 (1953).

A second γ-transition in the decay of Xe^{129m} has been found. The energy of the corresponding γ-ray is $40{\cdot}0 \pm 0{\cdot}5$ keV, and the $K/(L+M)$ ratio $4{\cdot}3 \pm 0{\cdot}7$. A decay scheme is presented. A.

539.166 : 539.172.13

10462. Gamma radiation from B^{10} bombarded by protons. R. B. Day and T. Huus. *Phys. Rev.* **95**, 1003–6 (*Aug.* 15, 1954).

A sodium iodide scintillation spectrometer has been used to study the γ-radiation produced when B^{10} is bombarded by protons. The following γ-rays have been found: a 432 keV γ-ray from the $B^{10}(p,\alpha\gamma)Be^{7}$ reaction, a 718 keV γ-ray from inelastic scattering in B^{10} and a high-energy γ-ray from the reaction $B^{10}(p,\gamma)C^{11}$. Excitation curves and cross-sections are given. A.

539.166 : 539.172.13

10463. Gamma radiation from the proton bombardment of oxygen. J. B. Warren, K. A. Laurie D. B. James and K. L. Erdman. *Canad. J. Phys.*, **32**, 563–70 (*Sept.*, 1954).

The nuclear γ-radiation following the non-resonant capture of a proton in O^{16} has been studied with protons of energies from 800 keV to 2·1 MeV and found to consist of three components. The main transition goes, via a γ-ray of energy that varies with proton bombarding energy, to the $J = \frac{1}{2}+$ state of F^{17}. This state, 487 keV above the ground state, radiates directly to the ground state. In addition there is a weaker direct radiative transition from the capture configuration to the ground state. At energies above $E_p = 1{\cdot}8$ MeV oxide targets bombarded with protons give rise to a radiation of 873 keV attributed to the presence of the O^{17} isotope via the reaction $O^{17}(p,p')O^{17*}$, the radiation corresponding to the transition from the first excited state of O^{17} to the ground state. A.

539.166.08 : 537.542

10464. A scintillation spectrometer. B. Åström. *Ark. Fys.* **7**, *Paper* 22, 241–5 (1953).

The design and performance of a scintillation spectrometer using NaI(Tl) crystals is described. A method of improving the overload characteristics of a linear amplifier and the circuit of a simple one-channel differential discriminator is given. A.

539.166.08 : 537.542

10465. Calibration of a scintillation spectrometer for the comparison of γ- and X-ray intensities. B. Åström, A. H. Wapstra, S. Thulin and I. Bergström. *Ark. Fys.*, **7**, *Paper* 22, 247–53 (1953).

The efficiency of a NaI(Tl) scintillation spectrometer (preceding abstract) for detecting electromagnetic radiations of different energies is determined by absorption methods, and by measuring isotopes with simple decay schemes and known internal-conversion coefficients. A.

539.166.74

10466. Nuclear resonance fluorescence in Hg^{198} and the lifetime of the 411 keV excited state of Hg^{198}. F. R. Metzger and W. B. Todd. Letter in *Phys. Rev.*, **95**, 853–4 (*Aug.* 1, 1954).

The resonance fluorescence scattering as a function of the temperature of the Au^{198} source for a mercury scatterer at room temperature was measured with scintillation counters. From the observed temperature dependence the lifetime of the first excited state in Hg^{198} was deduced to be $3{\cdot}15 \pm 0{\cdot}3 \times 10^{-11}$ secs. See also Abstr. 7113 (1953). J. Hughes

539.166.75

10467. Penetration of 6-MeV gamma rays in water. P. A. Roys, K. Shure and J. J. Taylor. *Phys. Rev.*, **95**, 911–12 (*Aug.* 15, 1954).

The penetration has been studied out to 190 cm. The dose rate has been measured with an anthracene scintillation detector as a function of the distance from the N^{16} source. The results agree closely out to 160 cm with the distribution calculated according to the theory of γ-ray penetration as developed by Spencer and Fano. A.

539.166.83

10468. *K*-conversion coefficients of γ-transitions occurring in the decay of Kr^{85m}, Xe^{129m}, Xe^{131m}, Xe^{133} and Xe^{133m}. I. Bergström, S. Thulin, A. H. Wapstra and B. Åström. *Ark. Fys.*, **7**, *Paper* 22, 255–63 (1953).

The *K*-conversion coefficients of γ-rays in the decays of Kr^{85m}, Xe^{129m}, Xe^{131m}, Xe^{133} and Xe^{133m} have been measured by a combination of β-spectrometer [Abstr. 6003 (1952)] and scintillation methods [Abstr. 10464–5 (1954)]. The empirical K/L curve of Goldhaber and Sunyar for *M*4 transitions has been slightly corrected. A.

539.166.83

10469. *K*-conversion coefficient of the isomeric γ-ray in Ag^{109}. A. H. Wapstra. *Ark. Fys.*, **7**, *Paper* 22, 265–8 (1953).

By scintillation spectrometer measurements the

K-conversion coefficient of the 40 sec Ag^{109m} isomeric transition is found to be $9 \cdot 5 \pm 1$ (E3 transition). A.

539.166.83

10470. The angular correlation of the conversion electrons of Cd^{111}. F. Gimmi, E. Heer and P. Scherrer. *Z. Phys.*, **138**, *No.* 3–4, 394–403 (1954) *In German.*

The (γ,γ), (e_K^-,γ), (γ,e_K^-) and $(e_K^- - e_K^-)$ correlations were measured for the Cd^{111} cascade, using a source which was sufficiently thin for electron scattering to be neglected, and which was uninfluenced by external fields. The experimental results were in agreement with theory. J. HUGHES

539.166.83

10471. The radiation loss during inner transformations. K. Baumann and H. Robl. *Z. Naturforsch.*, **9a**, 511–15 (*June*, 1954) *In German.*

The differential transition probability for inner bremsstrahlung accompanying internal conversion was calculated for electric and magnetic multipole transitions of any order, with the restrictions of low atomic number and considering only the K electrons. The energy and angular distributions for energetic quanta differ from the calculations of Chang and Falkoff [Abstr. 465 (1950)] only for small radiation loss. J. HUGHES

539.166.83

10472. Search for a 56 keV gamma line and the K-conversion of the 165 keV line in Ba^{139}. R. H. Nussbaum and R. van Lieshout. Letter in *Physica*, **20**, 440 (*July*, 1954).

A NaI scintillation spectrometer investigation of the radiation from Ba^{139} failed to confirm the reported existence of a 56 keV γ-radiation from La^{139}. A value of $0 \cdot 20 \pm 0 \cdot 04$ obtained for the K-conversion of the 165 keV line is in substantial agreement with that given by previous workers. L. R. SHEPHERD

539.166.83

10473. On the spectrum of conversion electrons emitted by $Am^{241} \xrightarrow{\alpha} Np^{237}$. J. Milsted, S. Rosenblum and M. Valadares. *C.R. Acad. Sci.* [*Paris*] **239**, 259–61 (*July* 19, 1954) *In French.*

Forty conversion lines between 9·93 and 94·40 keV, observed by magnetic spectrometer, are tabulated and classified. J. J. WILKINS

539.166.83

10474. Measurements of conversion coefficients with a scintillation spectrometer. *Ark. Fys.*, **7**, *Paper* 22, 239–91 (1953).

A series of 8 papers. For abstracts see Abstr. 10443, 10449, 10461, 10464–5, 10468–9, 10475 (1954).

539.166.83 : 539.165

10475. Conversion coefficients of the isomeric γ-ray in the decay of Ba^{137}. A. H. Wapstra. *Ark. Fys.*, **7**, *Paper* 22, 275–7 (1953).

From β-spectrometer measurements on Cs^{137} the K-conversion coefficient of the 662 keV transition in Ba^{137m} was found to be $0 \cdot 093 \pm 0 \cdot 006$ ($M4$ transition) and the K/L ratio $5 \cdot 8 \pm 0 \cdot 3$. The Kurie plot is straight down to 75 keV if a special correction factor is used. A.

539.166.83 : 615.849.7

10476. The electron spectra produced by a cobalt 60 source in water. E. Hayward. *Amer. J. Roentgenol.*, **71**, 333–6 (*Feb.*, 1954).

Electron spectra from a Co^{60} source were measured at various distances up to 161 cm in water, the source and detector both being immersed. The detector was a scintillation counter using an anthracene crystal, and designed to measure the energy of only those electrons produced in and totally absorbed by the crystal. Diagrams of the apparatus and plots of electron spectra as a function of distance from the Co^{60} source are given. D. MABBS

539.166.835

10477. Z-dependence of the cross-section for pair-production by ThC″ γ-rays. S. Barkan. *Rev. Fac. Sci. Univ. Istanbul C.*, **19**, 53–6 (*Jan.*, 1954).

An account of a series of experiments carried out in four different materials at γ-ray energy 2·6 MeV. The results are compared with the theoretical values calculated for the same energy. A comparison with the experimental values obtained for γ-ray energy equal to 1·5 MeV is also made. A.

539.166.835

10478. A modified scintillation pair spectrometer. B. Hird and C. Whitehead. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, 644–5 (*July*, 1954).

The three-crystal pair spectrometer has been modified to discriminate against unwanted coincidences from Compton electron and photon-pairs. Side crystal pulses are accepted only if they are of height corresponding to annihilation radiation. Distribution curves of pulse height v. counting rate for a Na^{24} source are given when various apertures were used. N. M. KING

539.166.835 : 530.145

10479. Radiation of photons and electron-positron pairs in a magnetic field. N. P. Klepikov. *Zh. éksper. teor. Fiz.*, **26**, *No.* 1, 19–34 (1954) *In Russian.*

The solution of Dirac's equation in a uniform magnetic field is derived and discussed. Asymptotic formulae, valid for large quantum numbers (radius $\geqslant 3\hbar E/c$), are applied to calculate the spectrum of the emitted radiation, the cross-section for the annihilation of e^- and e^+ with photon emission and the inverse process of pair creation by photons or electrons. These processes would not be observable with fields obtainable in the laboratory.

W. J. SWIATECKI

539.167.3

10480. Simple method for the preparation of uniform radioactive sources. G. Charpak and M. Chemla. Letter in *J. Phys. Radium*, **15**, 490–1 (*June*, 1954) *In French.*

The radioactive material is evaporated to dryness on a thin Pt backing, then sublimed on to a thin support film by a very brief heating to redness.

A. O. STANESBY

539.167.3

10481. Preparation of carrier-free lanthanum-140. M. L. Salutsky and H. W. Kirby. *Analyt. Chem.*, **26**, 1140–2 (*July*, 1954).

Tracer methods for lanthanum find limited usage because of the short half-life (40 hr) of the radioisotope lanthanum-140. A continual supply of

carrier-free lanthanum-140 can be obtained by "milking" it at intervals of a few days from its parent, barium-140 (12·8-day half-life). Barium-140 is precipitated with barium nitrate carrier from 80% nitric acid, and lanthanum-140 is recovered from the filtrate. A yield of about 90% was obtained, and high purity was indicated by the fact that the lanthanum-140 decayed with a 40 hr half-life for about 15 days. By use of this method a tracer supply of lanthanum-140 is available for several weeks from an initial source of a few millicuries of barium-140. A modified filter-beaker, specially adapted for radiochemical work, is described. A.

539.169

10482. Radioisotopes in science and technology. L. MEITNER. *Appl. sci. Res. B*, **4**, *No.* 1–2, 68–72 (1954) *In German.*

Gives examples of the application of tracer methods, which are not so generally well known, for problems in biology and pure chemistry.

539.169

10483. A method of measurement in physics and chemistry based on the distribution of radioactive particles. A. HEE AND P. KELLER. *J. Chim. phys.*, **51**, 178–80 (*April*, 1954) *In French.*

Ra(E + F) is deposited from solution on a Ni film. The distribution of α-particles from the deposit, and hence the distribution of the atoms in the solution, is studied by means of photographic plates. The method can be used in problems of hydrodynamics, of electrochemical kinetics of radioelements, and of radiocolloids. See Abstr. 1941, 3160 (1954).

J. HAWGOOD

NUCLEAR REACTIONS 539.17

539.17 : 523.12

10484. Remarks on the statistical account for ion forces in an equilibrium mixture of nuclei in a degenerate electron gas. G. BESKOW. *Mem. Soc. Roy. Sci. Liège*, **14**, *Special No.*, 55–67 (1954).

A discussion of the modifications to be introduced in the Klein–Beskow–Treffenberg theory of the origin of elements [Abstr. 5011 (1951)] when allowance is made for electrostatic forces. Preliminary calculations suggest that only minor changes are to be expected in the equilibrium distribution.

R. A. NEWING

539.17 : 523.877

10485. Experimental and theoretical results on nuclear reactions in stars. W. A. FOWLER. *Mem. Soc. Roy. Sci. Liège*, **14**, *Special No.*, 88–111 (1954).

A comprehensive review of laboratory measurements with extrapolations to stellar energies. Tabulated results give data for the C–N cycle reactions, the direct proton-proton chain and for proton reactions with Li, Be and B. R. A. NEWING

539.172

10486. An experimental investigation of nuclear reaction energies, energy levels in compound and residual nuclei and atomic masses of light nuclei. C. MILEIKOWSKY. *K. Tekn. Högsk. Avhandl.*, *No.* 84, 7 *pp.* (1953).

The author summarizes eight previously published papers on the acceleration of charged particles, their magnetic analysis, the design of a magnetic spectrometer and its use to measure the Q-values of a number of nuclear reactions. It is pointed out how the results thus obtained, together with those of Aldburger and Wong, make possible a nuclear reaction network connecting the atomic masses from hydrogen up to sulphur, where previously a break in the network occurred between the fluorine and neon isotopes.

D. R. CHICK

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 10306–8

539.172.11

10487. Elastic scattering of intermediate-energy alpha particles by heavy nuclei. G. W. FARWELL AND H. E. WEGNER. *Phys. Rev.*, **95**, 1212–17 (*Sept.*, 1954).

The deflected α-particle beam of the University of Washington 60 in. cyclotron has been used to study the elastic scattering of 13 to 42 MeV α-particles by Ag, Ta, Pb and Th at 60°. The α-particle energy was decreased in steps of approximately 1 MeV by placing remotely controlled absorbers in the cyclotron beam. Elastically scattered α-particles were selected and counted by a differential-range coincidence proportional-counter telescope. Up to a certain critical energy E_0, which increases with Z, the cross-section for each element decreases with increasing α-particle energy in agreement with the Rutherford formula. At higher energies, the dependence is given by the empirical formula $\sigma(E) = \sigma(E_0)\exp\{-E(K - E_0)\}$. The slope parameter K is about $0{\cdot}26\ \mathrm{MeV}^{-1}$ and decreases slightly as Z increases. Interpretation of results in terms of a semi-classical strong absorption model leads to values of the sum of nuclear radius and α-particle radius best fitted by the empirical formula $D = (1{\cdot}50A^{\frac{1}{3}} + 1{\cdot}4)\times 10^{-13}$ cm. A.

539.172.11

10488. Theory of elastic scattering of alpha particles by heavy nuclei. J. S. BLAIR. *Phys. Rev.*, **95**, 1218–22 (*Sept.* 1, 1954).

A semi-classical model is used to interpret recent experiments of Farwell and Wegner (preceding abstract) on the elastic scattering of 13–42 MeV α-particles by heavy nuclei. In this model the outgoing lth partial wave is assumed to vanish if the corresponding classical turning point is less than the radius of the nucleus plus that of the α-particle; otherwise, it has a phase characteristic of pure Coulomb scattering. The theory predicts that the sum of nuclear and α-particle radii is approximately equal to the classical apsidal distance evaluated at the energy for which the experimental cross-section is one-quarter of the corresponding Rutherford cross-section. A.

539.172.13

10489. Element 100 produced by means of cyclotron-accelerated oxygen ions. H. ATTERLING, W. FORSLING, L. W. HOLM, L. MELANDER AND B. ÅSTRÖM. Letter in *Phys. Rev.*, **95**, 585–6 (*July* 15, 1954).

An α-activity of energy 7·7 MeV and half-life ~ 0·5 hr, attributed to element 100, was found in the

products from the irradiation of U metal with $^{16}O^{6+}$ ions of max. energy ~180 MeV; from α-decay systematics, probable mass no. is 250. A. O. STANESBY

539.172.13

10490. The angular correlation between gamma-rays and alpha-particles from $^{7}Li(p\gamma)^{8}Be(\alpha)^{4}He$. E. K. INALL. Letter in *Phil. Mag.*, **45**, 768–71 (*July*, 1954).

The observations imply that the spins of the 4·09 and 5·3 MeV levels of Be^{8} are 2 and that there is a significant $E2$ component in the $M1$ radiation; the spin of the 7·5 MeV level is probably 0, but a value of 2 is not ruled out. A. O. STANESBY

539.172.13

10491. Resonant states of Mg^{24} excited by protons on sodium. P. H. STELSON AND W. M. PRESTON. *Phys. Rev.*, **95**, 974–81 (*Aug.* 15, 1954).

The γ-ray yield from sodium was measured as a function of proton bombarding energy over the range 1·0 to 2·5 MeV using resolutions of 2·5 keV or better. In addition, the yield of α-particles produced by the $Na^{23}(p, \alpha)Ne^{20}$ reaction and leading to the ground state of the residual nucleus was measured for proton energies of 1·0 to 2·2 MeV, with a resolution of 10 keV. Fifty-two resonances were observed in all. The resulting average level spacing is 28 keV at a mean excitation energy of 13·5 MeV in the compound nucleus Mg^{24}. The resonances vary in natural width from less than 0·3 keV to 50 keV. The energy spectra of the γ-rays from a number of resonances were investigated with a single-crystal NaI(Tl) scintillation spectrometer. The spectra consist mainly of two γ-rays, with energies of $0{\cdot}45 \pm 0{\cdot}01$ and $1{\cdot}63 \pm 0{\cdot}02$ MeV. These are interpreted as transitions from the first excited states of the residual nuclei formed by the reactions $Na^{23}(p, p')Na^{23}$ and $Na^{23}(p, \alpha')Ne^{20}$, respectively. A.

539.172.13

10492. Coulomb excitation of isomeric states in silver. T. HUUS AND A. LUNDÉN. *Phil. Mag.*, **45**, 966–72 (*Sept.*, 1954).

The time-delay in the decay of Coulomb excited nuclei can be used to improve background conditions so that weaker excitations can be detected. As an example the excitation of the 40 sec isomeric activity in silver was investigated. The measured yield curve shows that the excitation takes place mainly via a higher-lying rotational state. A brief discussion of the rotational spectrum and the decay scheme is given. A.

539.172.13 : 539.152.2

10493. Conservation of isobaric spin in the reaction $Be^{9}(p,\alpha)Li^{6}$. R. MALM AND D. R. INGLIS. *Phys. Rev.*, **95**, 993–9 (*Aug.* 15, 1954).

The reaction $Be^{9}(p, \alpha)Li^{6}$ involves transitions to the ground state and first excited state of Li^{6} which are shown to display only a gradual dependence on proton energy and no indication of resonance at the known γ-ray resonance at 2·565 MeV which goes by way of the second excited state of Li^{6}. This may be explained in terms of conservation of isobaric spin and verifies that the second excited state of Li^{6} has isobaric spin $T = 1$ (or odd charge parity) as does also the resonant state of the compound nucleus B^{10}. The lack of resonance in the two α-groups does not provide a very sensitive test of the purity of isobaric spin in the resonant state, because the contribution of an impurity would be superposed on a background, but the sharpness with which the γ-resonance falls off on the low-energy side does indicate that neighbouring $T = 0$ states have remarkably little $T = 1$ admixture. The observations were made by means of a 16 in. two-dimensional focusing magnetic spectrometer, the construction and characteristics of which are described. A.

539.172.13 : 539.167.3

10494. Separation of plutonium isotopes from natural uranium bombarded with protons. M. A. ROLLIER, H. TYRÉN, A. MALVICINI AND R. REPOSSI. *R.C. Accad. Naz. Lincei*, **16**, 493–9 (*April*, 1954) *In Italian.*

A detailed account is given of the chemical separation of plutonium isotopes. Measurements on the α-particle spectra give proof of the presence of the reaction $(p, 3n)$ and an indication of the reaction (p, n) on U^{238} for 40 MeV protons. P. ROTHWELL

539.172.13

10495. The angular distribution of protons from the $C^{12}(d, p)C^{13}$ reactions. S. TAKEMOTO, T. DAZAI, R. CHIBA, S. ITO, S. SUGANOMATA AND Z. WATANABE. *J. Phys. Soc. Japan*, **9**, 447–50 (*July–Aug.*, 1954).

The angular distributions of protons from the $Cd^{12}(d, p)C^{13}$ reactions have been observed at three low bombarding energies, 0·52, 0·63 and 0·84 MeV, using nuclear emulsions at the proton detector. Some details of experimental equipments and procedure are described. The angular distributions observed were then expanded into series of Legendre polynomials. The expansion coefficients are tabulated and also plotted against the bombarding energy together with those reported by other authors. Large asymmetries have been found in the angular distribution curves at these low bombarding energies. A.

539.172.13

10496. $Li^{7}(d, p)Li^{8}$ yield curve. S. BASHKIN. *Phys. Rev.*, **95**, 1012–15 (*Aug.* 15, 1954).

The absolute cross-section for the $Li^{7}(d, p)Li^{8}$ reaction has been measured from 700 keV to 3·3 MeV. Previously reported resonances are located at 800 keV and 1·04 MeV, corresponding to states in Be^{9} at 17·30 MeV and 17·49 MeV, respectively. A third resonance, indicated by the earlier work to be at 1·4 MeV, is not confirmed, from which it is concluded that Be^{9} does not have the 17·8 MeV level for which that reported resonance was evidence. Above 1·8 MeV, the yield is relatively flat, perhaps indicating the influence of stripping, rather than compound nucleus formation. A.

539.172.13

10497. Production of I^{124} by the deuteron bombardment of tellurium. T. HALL, M. SIEGEL, L. M. SHARPE AND D. PRESSMAN. *Phys. Rev.*, **95**, 1208 (*Sept.* 1, 1954).

The authors have observed a nuclear reaction not previously reported. The I^{124} was identified by decay and γ-ray pulse-height studies using a well-type scintillation counter. Some observations are given on the relative amounts of the different iodine isotopes produced by the bombardment. A.

539.172.13

10498. Coulomb excitation of energy levels in rhodium and silver. N. P. Heydenburg and G. M. Temmer. Letter in *Phys. Rev.*, **95**, 861–3 (*Aug.* 1, 1954).

New energy levels were found under bombardment with 6 MeV doubly charged helium ions (He^{2+}): Rh^{103}, 295 and 357; Ag^{107}, 318 and 413 and Ag^{109}, 305 and 400 keV (all $\pm$ 5 keV). Level schemes and spin assignments are given. A. O. STANESBY

539.172.13 : 539.164

10499. The α-activity induced in gold by bombardment with ions of carbon 13. W. E. Burcham. Letter in *Proc. Phys. Soc.* [*London*] *A*, **67**, 733–4 (*Aug.*, 1954).

The nuclides At^{205}, At^{207} and Po^{206} were detected; the last mentioned was probably a secondary product formed by way of At^{206}. The yields are consistent with the mechanism of compound nucleus formation (At^{210}) followed by neutron evaporation.

J. M. CASSELS

539.172.3

10500. Photoelectric disintegration of the Li^6 nucleus. I. Sh. Vashakidze and G. A. Chilashvili. Letter in *Zh. éksper. teor. Fiz.*, **26**, *No.* 2, 254–5 (1954) *In Russian.*

If, in view of the low threshold of 1·48 MeV (Glenn, 1952), the Li^6 nucleus is considered as an α and a d in relative motion, the theory of deuteron photodisintegration can be applied with slight modifications. At 2·76 MeV a cross-section of $\sim 0{\cdot}15\times10^{-30}$ cm^2 is obtained, consistent with experiment.

W. J. SWIATECKI

539.172.3

10501. On the photodisintegrations $^6Li(\gamma,d)^4He$ and $^6Li(\gamma,t)^3He$. E. W. Titterton and T. A. Brinkley. Note in *Austral. J. Phys.*, **7**, 350–1 (*June*, 1954).

The following results are reported from experiments using emulsions irradiated by $Li^7(p,\gamma)$ resonance γ-rays: $Li^6(\gamma,d)He^4$ reaction cross-section $\leqslant(2\pm2)\times10^{-30}$ cm^2 for the combined 17·6 MeV and 14·8 MeV γ-rays; $Li^6(\gamma,t)He^3$ cross-section $\leqslant(6\pm4)\times10^{-30}$ cm^2 for the 17·6 MeV γ-rays. J. J. WILKINS

539.172.3

10502. The neutrons and alpha-particles from the disintegration of ^9Be by 6 MeV gamma-rays. J. H. Carver, E. Kondaiah and B. D. McDaniel. *Phil. Mag.*, **45**, 948–56 (*Sept.*, 1954).

By measuring the total photo-neutron yield, the cross-section for neutron production from Be^9 under irradiation with the $F^{19}(p,\alpha,\gamma)$ radiation is found to be $\sigma_t=(12{\cdot}5\pm1{\cdot}2)\times10^{-28}$ cm^2. The energy spectrum of the two α-particles, which are emitted in coincidence in the break-up, has also been studied; the cross-section for all beryllium photo-processes which lead to the emission of two α-particles, both of whose energies exceeds 400 keV, is found to be $\sigma_\alpha=(12{\cdot}8\pm2{\cdot}5)\times10^{-28}$ cm^2. The near equality of σ_t and σ_α shows that the disintegration rarely proceeds through the Be^8 ground state, while a detailed examination of the coincident α-particle spectrum suggests that (γ,n) and (γ,α) reactions are present. The (γ,n) transitions are mainly through the 2·9 MeV excited state of Be^8 and the (γ,α) transitions mainly through the He^5 ground state, the branching ratio being roughly 1·2 : 1. A.

539.172.3

10503. The photoneutron and photoproton cross sections of silicon and magnesium. L. Katz, R. N. H. Haslam, J. Goldemberg and J. G. V. Taylor. *Canad. J. Phys.*, **32**, 580–92 (*Sept.*, 1954).

The (γ,n) and (γ,p) cross-sections were measured as a function of photon energy in a number of isotopes. They were found to have the resonance shapes characteristic of photo-nuclear reaction for which the pertinent data are summarized. In view of the fact that in each isotope the threshold for the (γ,p) reaction is higher than that for the (γ,n) reaction it is surprising to find the maximum (γ,p) cross-section to be at least equal to the maximum (γ,n) cross-section, while peaking at about 6 MeV higher energy. These results are discussed in some detail. A.

539.172.3

10504. The (γ,n) and (γ,p) cross sections of argon 40. D. McPherson, E. Pederson and L. Katz. *Canad. J. Phys.*, **32**, 593–8 (*Sept.*, 1954).

The (γ,n) and (γ,p) cross-sections in A^{40} have been measured as a function of photon energy from threshold to 24 MeV. The (γ,n) cross-section was found to have a peak value of 38 mbarns at 20 MeV and an integrated cross-section of 0·35 MeV-barn. These values for the (γ,p) cross-section were found to be 120 mbarns at >25 MeV and 0·54 MeV-barn respectively. In spite of the higher (γ,p) threshold, it was found that the two cross-sections were equal at 19·5 MeV and above this energy the (γ,p) cross-section became larger. This interesting result is discussed. A.

539.172.3

10505. The photo-production of an isomeric state in ^{207}Pb. J. M. Reid and K. G. McNeill. *Phil. Mag.*, **45**, 957–65 (*Sept.*, 1954).

The 0·8 sec activity produced in Pb by irradiation in the X-ray beam of a 23 MeV synchrotron was shown to arise from a disintegration of Pb^{208} by comparing the effects produced in a target of "natural" Pb and a similar target of Pb enriched in the 208 isotope. The γ-rays emitted by the short-lived activity were investigated with a scintillation spectrometer. The resulting spectrum, and the half-life of the activity agree with the known spectrum and half-life associated with the $i_{13/2}$ isomeric state in Pb^{207}. The reaction was thus determined to be $Pb^{208}(\gamma,n)Pb^{207*}$. An estimate of the threshold for the production of the isomer was made by comparing, at different settings of the maximum X-ray energy from the machine, the intensity of the isomeric activity and the activity produced in Ag. The value thus obtained was 9·0 $\pm$ 0·1 MeV. The threshold calculated from the ground-state mass differences, the energy of the isomeric level and the centrifugal barrier corresponding to the orbital angular momentum of the emitted neutron is shown to be significantly greater than 9·0 MeV. It is suggested that the isomeric state is reached, not directly, but through a level of spin $\frac{11}{2}$ lying slightly above the isomeric level. A.

539.172.3

10506. Photoprotons from cobalt. M. E. Toms and W. E. Stephens. *Phys. Rev.*, **95**, 1209–11 (*Sept.* 1, 1954).

The charged particles ejected from a thin cobalt foil by the bremsstrahlung X-rays from a 24 MeV betatron have been observed in nuclear emulsions. Yields measured in units of 10^4 particles per mole per roentgen are: protons, 49 ± 10; deuterons, less than 1; α-particles $1{\cdot}6 \pm 0{\cdot}5$ (corrected for absorption in cobalt foil). The angular distribution of the photoprotons could be fitted with a curve of the shape of $I(\theta) = 71 + 8(\sin\theta + \sin\theta\cos\theta)^2$. The photoproton energy distribution can be accounted for mainly by evaporation from a compound nucleus, although 5 or 10% could be from a direct process. The relative absence of photo-deuterons in cobalt, compared with the case of copper which has similar binding energies, suggests that the shell structure may be important in allowing photo-deuteron emission. A.

539.172.3

10507. Relative photofission yields of several fissionable materials. J. R. Huizenga, J. E. Gindler and R. B. Duffield. *Phys. Rev.*, **95**, 1009–11 (*Aug.* 15, 1954).

Relative photofission yields of U^{238}, U^{236}, U^{235}, U^{234}, U^{233}, Th^{232}, Np^{237} and Pu^{239} were measured at three betatron energies with a photomultiplier fission fragment detector. Results at betatron energies of 17 and 20 MeV are in agreement and give the following relative fission values: Th^{232}, 0·31; U^{238}, 1·00; U^{236}, 1·43; U^{235}, 2·40; U^{234}, 1·82; U^{233}, 2·54; Np^{237}, 2·40; Pu^{239}, 3·17. The relative (γ, f) yields are empirically correlated with the nuclear parameter Z^2/A. Some comments are made on the competition between fission and neutron emission. A.

539.172.3

10508. Uranium photofission yields. R. A. Schmitt and N. Sugarman. *Phys. Rev.*, **95**, 1260–7 (*Sept.* 1, 1954).

The photofission yield-mass curve of natural uranium for 48 MeV X-rays was determined radiochemically. Isolation of selected peak and trough fission products at various maximum X-ray energies, 7 MeV, 10 MeV, 16 MeV, 21 MeV, 48 MeV, 100 MeV and 300 MeV showed that the peak-to-trough ratio decreased from 300 to 4 as the maximum X-ray energy increased from 7 MeV to 300 MeV. The observed photofission yield curves may be quantitatively interpreted as the superposition of two components, a low-energy asymmetric (double-humped) curve and a high-energy single-humped curve. The average cross-section for asymmetric fission for photons in the energy range 16 MeV to 300 MeV is about 7 millibarns. A.

539.172.4

10509. Demonstration of the reaction $C^{13}(n, \alpha)Be^{10}$ by scintillation counter. P. Savel and M. E. Nahmias. *C.R. Acad. Sci.* [*Paris*] **238**, 2155–6 (*May* 31, 1954) *In French.*

Using neutrons produced by 6·7 MeV deuterons incident on lithium, the reaction has been established by direct detection of the α-particles. The cross-section is at least $1{\cdot}4 \times 10^{-27}$ cm^2. J. J. Wilkins

539.172.4

10510. Thermal neutron capture cross sections of hydrogen, boron, and silver. F. R. Scott, D. B. Thomson and W. Wright. Letter in *Phys. Rev.*, **95**, 582–4 (*July* 15, 1954).

These were obtained by measuring the mean life of thermal neutrons in water and in solutions of B_2O_3 and $AgNO_3$ as a function of the liquid depth. $\sigma_H = 0{\cdot}323 \pm 0{\cdot}008$; $\sigma_B = 744 \pm 20$ and $\sigma_{Ag} = 58{\cdot}0 \pm 2 \times 10^{-24}$ cm^2/atom at a neutron velocity of 2200 m/sec. A. O. Stanesby

539.172.4

10511. Some pile neutron cross sections of isotopes of americium, berkelium, californium, and element 99. B. G. Harvey, H. P. Robinson, S. G. Thompson, A. Ghiorso and G. R. Choppin. Letter in *Phys. Rev.*, **95**, 581–2 (*July* 15, 1954).

The experiments were performed in the Materials Testing Reactor. For Am^{243}, $\sigma = 140 \pm 50$ barns; Bk^{249}, 1100 ± 300; Cf^{249}, 270; Cf^{252}, 30; Cf^{254}, <2; 99^{253}, 160; and 99^{254}, < 15; the fission cross-section of Cf^{249} is ~ 630 barns. A. O. Stanesby

539.172.4

10512. Neutron inelastic scattering. R. M. Kiehn and C. Goodman. *Phys. Rev.*, **95**, 987–92 (*Aug.* 15, 1954).

Neutron inelastic scattering cross-sections of Fe, Al, Cr, Ni, Pb and Bi have been measured with ~ 20 keV resolution for neutron energies between 0 and 2·7 MeV. A γ-ray spectrometer measured the mono-energetic γ-rays emitted by the excited nucleus. The cross-sections are in agreement with predictions based on the Hauser–Feshbach theory. The energies of the first few excited states of the stable nuclei were found to be in good agreement with values obtained by other means. A.

539.172.4

10513. Time-of-flight measurements on the inelastic scattering of 14·8-MeV neutrons. G. K. O'Neill. *Phys. Rev.*, **95**, 1235–45 (*Sept.* 1, 1954).

Measurements have been made of the energy spectra of neutrons inelastically scattered from 14·8 MeV into the interval 0·5–4 MeV. Carbon, aluminium, copper, tin and lead scatterers were used. 100 keV deuterons were extracted from a cyclotron and allowed to strike a target of tritium absorbed in zirconium. The resulting reaction $T^3(d,n)He^4$ (17·7 MeV in the centre-of-mass system) yielded a 14·8 MeV neutron accompanied by a recoil 3 MeV α-particle. A scintillation counter within the vacuum system, subtending a solid angle of $4\pi/100$ at the target, detected recoil α-particles with $\sim 100\%$ efficiency, delivering a fast signal whenever a neutron started on a path within a cone chosen to avoid scattering material for a distance of several metres. Within the cone and close to the target a scatterer was placed. The inelastically scattered neutrons emerged from the scatterer with approximate isotropy, while few elastically scattered neutrons were deflected through large angles. A proton-recoil neutron counter placed at $\sim 90°$ to the cone axis was thus prevented from detecting almost all undesired neutrons. The distance from the scatterer to the counter was 50 to 100 cm, and neutron energies were obtained from the measured

flight times over this path length, with the recoil α-signal serving as a time zero. The flight times, which were from 20 to 65 millimicroseconds, were measured by a time analyser having nine $4{\cdot}7\times10^{-9}$ second channels, recording directly on mechanical registers. Experimentally, neutron energies after scattering could be approximated by number/unit energy $E=E\exp(-E/T)$ with T, the "nuclear temperature" in MeV obtained from the raw data being: Pb, 0·75; Sn, 0·62; Cu, 0·84; Al, 1·06; C, 0·93. These results are in general agreement with photographic plate data. The experimentally observed angular distributions were isotropic within the limits of error of $\sim 15\%$. Over-all limits of error of $\pm$ 15% in the nuclear temperatures are assigned. A.

539.172.4

10514. The effective fission cross-section of uranium measured as a function of the velocity of the neutrons. R. Keller. *Arch. Sci.* [*Geneva*] **6**, *No.* 5, 280–4 (1953) *In French.*

The fission cross-section of U^{235} and the $B(n,\alpha)$ cross-section were compared for slow neutrons of several selected velocities. The fission cross-section does not seem to obey exactly the $1/v$ law.

J. M. CASSELS

539.172.4

10515. Fine structure in U^{233} fission. E. P. Steinberg, L. E. Glendenin, M. G. Inghram and R. J. Hayden. Letter in *Phys. Rev.*, **95**, 867–8 (*Aug.* 1, 1954).

An abnormally high yield of fission products with a maximum at about mass 99 is observed in the slow neutron fission of U^{233}. This high yield corresponds to fission products which are complementary to heavy fragments with 82 neutrons and masses around 133.

L. R. SHEPHERD

539.172.4

10516. Nuclear reactors. K. Wirtz. *Naturwissenschaften* **41**, *No.* 12, 269–77 (1954) *In German.*

Review article with short descriptions of the construction and performance of existing reactors throughout the world. A. O. STANESBY

539.172.4

10517. Control of the Saclay reactor. J. Weill. *Onde élect.*, **33**, 692–701 (*Dec.*, 1953) *In French.*

Describes the Saclay reactor which uses uranium rods plunged vertically into heavy water. Ionization chambers of the boron-carbide type are used for measurement of the reactor power by means of the slow neutrons produced. The ionization chambers are connected to pre-amplifiers using electrometer valves and thence via long cables to d.c. amplifiers with overall feedback. A circuit diagram of the arrangement is given and safety arrangements are described. Automatic equipment indicates the level of the heavy water, thus permitting accurate control of the amount required. The positions of the plates for regulating the activity of the pile are adjusted from the control console by means of a servo-mechanism system. Ionization chambers with associated amplifiers are also used for measurement of the pile reactivity and of the ionization at 7 points in the hall containing the pile. The general arrangements for temperature and loss measurements are shown in diagrams. A. WILKINSON

539.172.4

10518. Control of the cooling equipment of the Saclay reactor. G. Leduc. *Onde élect.*, **33**, 702–12 (*Dec.* 1953) *In French.*

The properties of various possible gas refrigerants are reviewed and a detailed account is given of (*a*) the nitrogen/water system used for cooling the active uranium rods (*b*) the air-cooling system for the tank containing the heavy water, (*c*) the arrangements for extracting the vapour above the surface of the heavy water in the tank, cooling it and returning it to the reservoir. A. WILKINSON

539.172.4

10519. Studies on the possibilities of using nuclear photographic emulsions in connection with reactors. H. B. Klepp and D. D. Popović. *JENER Rep.*, *No.* 25, 4 + iii *pp.* (*April*, 1954).

Measurements of the ratio of neutron flux to γ-ray background at various points in the Jener reactor (JEEP) are described. Considerable reductions in γ-ray blackening of emulsions has been achieved by desensitizing the emulsions and by enclosing them in bismuth containers. J. J. WILKINS

539.172.4

10520. Some aspects of non-linear reactor dynamics. W. K. Ergen and A. M. Weinberg. *Physica*, **20**, 413–26 (*July*, 1954).

The inherent stability of high-power nuclear reactors, in which there is coupling between temperature and reactivity, is examined. The analogy with a mechanical system of a ball rolling on a curved surface is demonstrated. Different systems are considered, namely, an uncooled reactor; heat removed in proportion to the excess of fuel temperature above ambient; constant heat removal; the circulating fuel reactor. The effect of delayed neutrons is examined briefly in the case of a system with constant heat removal. L. R. SHEPHERD

539.172.4 : 621.039.4 : 621.3.012.8

10521. Electric circuit models of the nuclear reactor. G. Kron. *Commun. and Electronics* [*New York*], *No.* 13, 259–65 (*July*, 1954).

A series of equivalent circuits are established for the partial differential equations representing the diffusion of neutrons in a reactor. One-, two- and three-dimensional spatial models, valid for all curvilinear orthogonal reference frames, are given first for mono-energetic neutrons. The presence of variable-energy neutrons is represented next by the appearance of a fourth dimension. Variation of neutron density in time is also considered along an extra fifth dimension. Circuit models with arbitrary shapes and with tens of thousands of net points may now be solved quickly and efficiently with the aid of digital computers by the recently developed tensorial method of tearing the model apart into smaller parts and solving each part separately. The effect of movable and variable control fixtures in the reactor, also a variation in composition, may now be considered without repeating the solutions arrived at for the rest of the reactor. A.

ATOM AND MOLECULE BEAMS . MESONS . NEUTRONS 539.18

539.18 : 530.145

10522. Mesons and nuclear forces. H. A. BETHE. *J. Washington Acad. Sci.*, **44**, 97–105 (*April*, 1954). Also in *Physics Today*, **7**, 5–11 (*Feb.*, 1954).

This article is a popular review of the present status of the derivation of nuclear forces from meson theory, of meson scattering by nucleons and of experimental facts about mesons. G. E. BROWN

539.18

10523. Decay curve of *K* particles. L. MEZZETTI AND J. W. KEUFFEL. Letter in *Phys. Rev.*, **95**, 858–60 (*Aug.* 1, 1954).

Charged unstable particles, formed in a generating layer of Pb, pass through a liquid scintillator, and stop in or near a Cherenkov counter, which detects charged, upward-going relativistic secondaries. The distribution of time delays, measured with a 17-channel chronotron type timing circuit, shows a central peak, and an exponential tail beginning at about 12·4 mμsec. Instrumental timing errors, studied by inverting the Cherenkov counter, give a distribution consistent with the central peak, but cannot account for the tail. Analysis of the lags greater than 12·4 mμsec gives a mean life of $8{\cdot}7 \pm 1{\cdot}0$ mμsec. The rate of such events is $3{\cdot}5\ \mathrm{hr}^{-1}$. It is likely that the particles observed are the $K_\mu \rightarrow \mu + \nu$. P. ROTHWELL

539.18

10524. On the question of the identification of heavy negative mesons in photoemulsions. M. I. PODGORETSKIĬ. Letter in *Zh. éksper. teor. Fiz.*, **26**, *No.* 2, 255–6 (1954) *In Russian.*

If a negative τ decays after capture into a Bohr orbit the coplanarity of the resulting 3 π's will be distorted: by 3–6° in a C mesic atom and completely absent for a Br atom. Also, conversion electrons (10–100 keV) emitted during the spiralling of the τ towards the *K*-orbit would characterize events with negative τ's. W. J. SWIATECKI

539.18

10525. The π^-/π^+ ratio from deuterium near photopion threshold. M. BENEVENTANO, D. CARLSON-LEE, G. STOPPINI, G. BERNARDINI AND E. L. GOLDWASSER. Letter in *Nuovo Cimento*, **12**, 156–9 (*July*, 1954).

Experiments using nuclear emulsion detectors and up to 300 MeV bremsstrahlung are described. Ratios $\sim 1{\cdot}5$ are reported for angles of emission between 75° and 150°. J. J. WILKINS

539.18

10526. Watson's type relations for Λ-particle production. R. GATTO. Letter in *Nuovo Cimento*, **12**, 160–2 (*July*, 1954).

Relations are obtained on the assumption of charge independence. Thus, for example, for an incident proton on a target nucleon which is a proton and neutron with equal probabilities, $N_{++} + N_{-} = N_{+} + N_0$, where N_{++}, N_{+}, N_0 and N_{-} are respectively the average number of doubly charged, single charged, neutral and negatively charged Λ-particles which emerge after the collision. G. E. BROWN

539.18

10527. Photopion *S*-wave near threshold and the pion nucleon coupling constant. G. BERNARDINI AND E. L. GOLDWASSER. Letter in *Phys. Rev.*, **95**, 857–8 (*Aug.* 1, 1954).

Measurements on π^+ photoproduction from hydrogen at 90° (c.m.) are reported, and the results are analysed together with other available data. J. J. WILKINS

539.18

10528. Charged pion production from carbon by protons. W. F. DUDZIAK. Letter in *Phys. Rev.*, **95**, 866 (*Aug.* 1, 1954).

Results of a study of cross-sections for production of positive and negative pions in carbon, using photographic plates, are reported. The proton source was the external electrically deflected beam of the 184 in. synchrocyclotron. P. ROTHWELL

539.18

10529. Meson production in *n*–*p* collisions at cosmotron energies. W. B. FOWLER, R. P. SHUTT, A. M. THORNDIKE AND W. L. WHITTEMORE. *Phys. Rev.*, **95**, 1026–44 (*Aug.* 15, 1954).

154 analysable three-prong events were observed in collisions between cosmotron-produced neutrons, with energies up to 2·2 BeV, and protons in a hydrogen-filled diffusion cloud chamber. These events were classified as a result of the reactions $n + p \rightarrow p + p + \pi^-$, $p + p + \pi^- + \pi^0$ and $p + n + \pi^+ + \pi^-$ with frequencies in the ratio $(0{\cdot}8 \pm 0{\cdot}3) : (1 \pm 0{\cdot}35) : (3{\cdot}2 \pm 0{\cdot}7)$, respectively. The observed ratio of the probability for double meson production to that for single meson production is more than 20 times higher than the ratio predicted from Fermi's statistical model. No triple meson production is observed, in agreement with the statistical model. The momentum distributions of the observed mesons are also in rough agreement with the theory. In the centre-of-mass system, in the reaction $n + p + \pi^+ + \pi^-$, protons and π^+ show a tendency to be emitted backward, while neutrons and π^- tend towards forward emission. However, the data suggest that protons and π^+, and also neutrons and π^-, tend to be emitted more frequently in opposite directions than protons and π^- or neutrons and π^+. All of these results may be qualitatively in agreement with a meson production model where each nucleon is excited separately to an intermediate, possibly resonant, state which subsequently decays by emission of a meson. A.

539.18 : 530.145

Non-local interaction and multiple meson emission. *See Abstr.* 9934

539.18

10530. Scattering of 187-MeV negative pions by hydrogen. M. GLICKSMAN. *Phys. Rev.*, **95**, 1045–7 (*Aug.* 15, 1954).

The differential cross-sections for scattering of 187 MeV negative pions in hydrogen have been observed at six angles. The scattering is well represented by the angular distributions in the barycentric system: $\pi^- + p \rightarrow \pi^- + p$: $d\sigma/d\omega = 0{\cdot}81 \pm 0{\cdot}13 + (0{\cdot}35 \pm 0{\cdot}20)\cos\chi + (3{\cdot}08 \pm 0{\cdot}38)\ \cos^2\chi \times 10^{-27}$ cm^2/sterad. $\pi^- + p \rightarrow \pi^0 + n$: $d\sigma/d\omega = 1{\cdot}46 \pm 0{\cdot}24$

$-(0\cdot16 \pm 0\cdot30)\cos\chi + (5\cdot63 \pm 0\cdot88)\cos^2\chi \times 10^{-27}$ cm²/sterad. A transmission measurement of the total cross-section gave $63\cdot5 \pm 1\cdot6 \times 10^{-27}$ cm². An analysis of these data in terms of phase shifts is discussed. A.

539.18

10531. Application of the intermediate coupling theory to the scattering of pseudoscalar mesons by a nucleon. G. TAKEDA. *Phys. Rev.*, **95**, 1078–84 (*Aug.* 15, 1954).

Tomonaga's intermediate coupling theory is applied to the scattering of pseudoscalar mesons by a nucleon. The scattering cross-section depends on the cut-off momentum of the meson field and the coupling strength between the nucleon and the meson field. For reasonable values of the coupling strength, the wave-function of the meson field around a nucleon was calculated numerically. By making use of these results the scattering phase shifts are calculated for various values of the cut-off momentum. Agreement with recent experimental results is not very good, although most of the qualitative features of the experiments are reproduced. A modification of the source function of the meson field can be expected to give a better fit with the experimental results. A.

539.18

10532. Total cross section for charge exchange scattering of π^- mesons by hydrogen at 42, 30, and 20 MeV. W. J. SPRY. *Phys. Rev.*, **95**, 1295–300 (*Sept.* 1, 1954).

A measurement of the total cross-section for the reaction $p(\pi^-, \pi^0)n$ has been made at three energies using polyethylene and carbon targets in a difference experiment. The values obtained for the cross-sections are $\sigma(42\text{ MeV}) = 6\cdot9 \pm 1\cdot2$ mb; $\sigma(30\text{ MeV}) = 5\cdot7 \pm 0\cdot9$ mb; and $\sigma(20\text{ MeV}) = 5\cdot0 \pm 0\cdot8$ mb. The results are analysed under the assumption of charge independence in an attempt to determine the energy dependence of the *S*-wave phase shifts. A.

539.18

10533. Large angle scattering of μ-mesons in lead. I. B. MCDIARMID. *Phil. Mag.*, **45**, 933–47 (*Sept.*, 1954).

A multiplate cloud-chamber, operated underground, has been used to investigate the scattering of μ-mesons in lead over a wide range of meson energies. The large angle "tails" of the measured distributions have been compared with those expected from Molière's theory for a "point" nucleus and Olbert's modification of this theory for a "solid" nucleus. At energies of a few hundred MeV the method used is not capable of distinguishing between these two theories but at higher energies the measured distributions fall very near to those expected from Molière's theory. No explanation of these departures from the expected distributions for a "solid" nucleus is offered, but they are in agreement with those found by other workers. It is pointed out that such departures may be due to deficiencies in the theory and do not necessarily indicate a non-Coulomb interaction between fast μ-mesons and nucleons. A.

539.18

10534. The anomalous scattering of μ-mesons. G. D. ROCHESTER AND A. W. WOLFENDALE. *Phil. Mag.*, **45**, 980–5 (*Sept.*, 1954).

A re-examination of the data on the scattering of fast μ-mesons in the photographic emulsion has been made for a number of nuclear models. It is shown that the most reasonable models still predict less scattering than is observed. However, because of the absence of an exact model of the nucleus and exact scattering calculations for μ-mesons, it is not possible to conclude that the anomaly indicates the existence of a non-electric, short-range interaction between the μ-meson and the nucleon. A.

539.18 : 539.152.1

10535. Scattering of μ-mesons and charge distribution in atomic nuclei. H. MARSCHALL. *Z. Phys.*, **138**, *No.* 1, 93–104 (1954) *In German.*

A preliminary investigation is made into the dependence of elastic scattering of μ-mesons on the nuclear charge distribution. The coupling between μ-mesons and nuclei is assumed to be through the Coulomb potential alone and relativistic effects are neglected. The differential cross-sections for the two extreme cases of uniform volume and surface distributions of protons in a heavy nucleus (Pb) are calculated for 25 MeV and 50 MeV mesons. It appears that for a suitable energy range, scattering experiments with μ^+-mesons and heavy nuclei could give the required information. G. FIELD

539.18

10536. Bound states of π-mesons. K. HAIN. *Z. Naturforsch.*, **9a**, 495–508 (*June*, 1954) *In German.*

The possibility is considered of two π-mesons, in interaction with the nucleon field, forming a bound state. Selection rules allow for a *P*-state of differently charged mesons with a Bethe–Salpeter wave-function symmetric in relative times and anti-symmetric in isotopic spin, and a *P*-state of similar mesons, symmetric in relative times and transforming like a pseudo-vector for space-time reflections. Perturbation theory calculations show that the interaction consist of two parts, a repulsive δ-interaction, which might explain saturation, since it corresponds to the non-local term in Schiff's equation, and an attractive potential with range half the proton Compton wavelength. Solving the B.S. equation by the Ritz method, with this interaction, the bound state for unlike mesons is possible for a coupling constant about 14, and for neutral mesons about 8. P. T. MATTHEWS

539.185

10537. Applications of the theory of the slowing down of neutrons. M. DEMEUR, A. GRIBAUMONT AND P. JANSSENS. *Bull. Acad. Roy. Belgique Cl. Sci.*, **40**, 526–38 (*May*, 1954) *In French.*

Langevin's method [*C.R. Acad. Sci.* [*Paris*] **214**, 517, 817 (1942)] is applied (*a*) to calculate the probability that a neutron passes from an energy $> E_1$ to an energy $< E_2$ in a single collision, and (*b*) to the problem of specific (plane or point) source geometrics. For problems involving no special conditions, the transport equation method is shown to provide a more compact solution. J. J. WILKINS

539.185 : 537.534

10538. A versatile 150 kV neutron generator. E. BLOMSJÖ AND G. F. VON DARDEL. *Appl. sci. Res. B*, **4**, *No.* 1–2, 49–67 (1954).

A 150 kV accelerator has been built, intended chiefly for neutron production, with a special mounting which makes it very easy and convenient to handle.

The considerations leading to the ultimate design are reported. Details are given of the construction of the main apparatus, the safety system, the cooling system, and the deuterium supply for the ion source. Investigations concerning targets suitable for the D–D reaction and some other measurements which have been made with the apparatus are reported. A.

539.185

10539. Scattering of slow neutrons by liquids. II. Scattering of 80°K neutrons in CH_3OH and CH_3I. J. A. Janik. *Bull. Acad. Polon. Sci. Cl.* 3, **2**, *No.* 5, 225–7 (1954).

For Pt I, see Abstr. 1766 (1954). The molecular scattering cross-section of CH_3OH was found to increase as the neutron temperature was reduced, whereas that of CH_3I stayed constant. This result is discussed. J. M. CASSELS

539.185

10540. Neutron–proton scattering at 300 MeV. J. De Pangher. Letter in *Phys. Rev.*, **95**, 578–9 (*July* 15, 1954).

This was examined in a cloud chamber ($H_2O + H_2$ only) irradiated with neutrons (most probable energy ~ 310 MeV) obtained by the bombardment of a LiD target with 340-MeV protons inside a cyclotron. The angular distribution, based on 2057 tracks, is given for the neutrons ($E_n > 200$ MeV) in the centre-of-mass system (proton dip angle $< 40°$) and is compared graphically with similar data obtained using counter methods [Kelly, *et al.*, Abstr. 8240 (1950)]; the agreement is considered satisfactory. A. O. STANESBY

539.185

10541. Small-angle neutron–proton scattering at 400 MeV. A. J. Hartzler, R. T. Siegel and W. Opitz. Letter in *Phys. Rev.*, **95**, 591–2 (*July* 15, 1954).

Previous experiments [Abstr. 8632 (1954)] were extended to centre-of-mass neutron scattering angles $< 40°$, using a scattered neutron detector. Results for c.m. scattering angles from 12·7–180° are given in graphical and tabular form. A. O. STANESBY

539.185

10542. Scattering of 1·32-MeV neutrons by protons. C. L. Storrs and D. H. Frisch. *Phys. Rev.*, **95**, 1252–9 (*Sept.* 1, 1954).

The total cross-sections of polyethylene and graphite for scattering of neutrons of $1·315 \pm 0·003$ MeV have been measured and are $\sigma(CH_2) = (9·542 \pm 0·035) \times 10^{-24}$ cm^2 and $\sigma(C) = (2.192 \pm 0·020) \times 10^{-24}$ cm^2. From these the hydrogen cross-section is $\sigma(H) = (3·675 \pm 0·020) \times 10^{-24}$ cm^2. If the best current values of the binding energy of the deuteron, the coherent scattering length, and the epithermal cross-section are used, the singlet effective range in the shape-independent approximation is $(2·4 \pm 0·3) \times 10^{-13}$ cm. This is to be compared with the proton–proton singlet effective range of $(2·7 \pm 0·1) \times 10^{-13}$ cm. A.

539.185.08 : 539.172.4

10543. Measurements of the fast neutron flux in the centre of JEEP. B. Grimeland. *JENER Rep.*, *No.* 28, 9 *pp.* (*July*, 1954).

In many cases (n,p) or (n,α) reactions induced by fast neutrons lead to radioactive nuclei. By using published cross-sections it was possible to measure the fast neutron flux. The absolute β-activity was measured with a plastic scintillator and a photomultiplier tube. The flux of fast neutrons at the centre of JEEP (channel 5–11) was found to be $(2·3 \pm 0·3) \times 10^5$ neutrons/cm^2.sec^1.watt^1. The experiments indicate that the cross-section for the reaction $S^{32}(n,p)P^{32}$ is about 45 barns instead of 30 as given in published data. A.

STRUCTURE OF SOLIDS 539.2

539.21 : 532.7

10544. Application of a theory of Borelius to the relation between the structure of solid and liquid iron. O. Krisement and F. Wever. *Appl. sci. Res. A*, **4**, *No.* 4, 249–65 (1954) *In German.*

The idea that the entropy and internal energy of a substance can be separated into vibrational, electronic and structural terms is tested on iron. It is found that liquid iron is in this respect very like α (δ) iron, and not like γ-iron, lending limited support to Borelius' theory that there exists a continuous (unstable) range of states between solid and liquid, through which the structure is to some extent maintained. W. M. LOMER

539.211.08

10545. A reflectometer for the assessment of surface texture. J. Halling. *J. sci. Instrum.*, **31**, 318–20 (*Sept.*, 1954).

Describes a simple optical-mechanical instrument which gives a rapid assessment of the surface texture of machined surfaces. The action of the instrument depends on the variation of the specular reflexion of the surface with varying angle of incidence. The variation of specular reflexion is assessed by observation of the variation in the definition of the images from an illuminated screen consisting of a series of lines. Two methods of use of the instrument are described, one as a comparator and the other for direct measurement. Using surface-ground mild-steel surfaces the experimental and theoretical relation between the response of the instrument and the centre line average value, obtained using a Talysurf, are given. A.

539.215.2 : 519.242.35

10546. Converting a number distribution of particle size into one for volume or surface area. M. E. Wise. *Philips Res. Rep.*, **9**, 231–7 (*June*, 1954).

A number distribution of equivalent radii of particles in a powder can be accurately converted into a distribution by volume or surface area, even if the data are highly and/or non-uniformly grouped. A formula is derived to do this and is applied to a microscope analysis into a frequency distribution of radii between 1, $\sqrt{2}$, 2, $2\sqrt{2}$, 4, . . . units. A.

539.215.4

10547. Automatic particle-sizing by successive counting. G. Jordanides and N. H. Chamberlain. Letter in *Nature* [*London*] **174**, 83–4 (*July* 10, 1954).

A spiral scanning photoelectric system indicates the presence of opaque particles by a series of pulses whose size varies with the size of the particle. A biased diode

clipping circuit enables all pulses below a certain size to be rejected and the others passed to a counter. By plotting a graph of the number of pulses counted as a function of the diode voltage it is possible to derive an expression for the number of particles and their mean diameter. Trials show that the method is very successful. J. M. HOUGH

539.217

10548. Theory of the diffusion of extraneous atoms in alloys during the process of ordering. I. M. A. KRIVOGLAZ AND A. A. SMIRNOV. *Zh. éksper. teor. Fiz.*, **24**, *No.* 4, 409–18 (1953) *In Russian.*

Discusses the problem of the diffusion of atoms inserted into the interstices of the body-centred crystal lattice of binary alloys, e.g. β-brass, during the ordering process. All possible configurations of the alloy atoms surrounding the diffusing atoms of the extraneous element are taken into consideration. A derivation is presented of theoretical dependence of the coefficient of diffusion on temperature and concentration for both the ordered and disordered state of the alloy. F. LACHMAN

539.217

10549. Two-material films. I. Diffusion of silver in tellurium. G. C. MÖNCH. *Ann. Phys.* [*Leipzig*] **14**, *No.* 6–8, 363–6 (1954) *In German.*

The diffusion of silver into tellurium was observed in thin evaporated films on supports of either glass or collodion films. Changes in optical transmission, electrical properties and electron diffraction enable the course of the reaction to be followed. W. M. LOMER

539.217

10550. Two material films. II. Film-thickness, temperature and substrate dependence of diffusion of silver in tellurium. T. MOHR. *Ann. Phys.* [*Leipzig*] **14**, *No.* 6–8, 367–76 (1954) *In German.*

The breadth of the diffusion zone was followed optically for various thicknesses of film in the temperature range 0–192°C. Changes in thickness in the diffusion zone give rise to wrinkles. On mica and glass the rates are equal, and governed by an activation constant 6910 deg^{-1}. Diffusion may be either accelerated or hindered by a scratch on the substrate. W. M. LOMER

539.217

10551. Two-material films. III. Volume changes during diffusion of silver into tellurium. T. MOHR. *Ann. Phys.* [*Leipzig*] **14**, *No.* 6–8, 377–84 (1954) *In German.*

Changes in film thickness were measured at constant temperature (140°C) by an interferometric method. The volume change between Te and Ag_2Te is 100%; it may occur as a crumpling or as a thickening of the sheet according to its original thickness. W. M. LOMER

539.217

10552. Two-material films. IV. Electron diffraction investigations on thin silver–tellurium films. U. ZORLL. *Ann. Phys.* [*Leipzig*] **14**, *No.* 6–8, 385–90 (1954) *In German.*

The Te film as prepared may be either hexagonal crystals or apparently amorphous. In the diffusion zone above 150°C a cubic modification of Ag_2Te is found, below this temp. a pattern which has not been indexed but which may correspond to the known low-temp. form of Ag_2Te. Near the pure Ag extra rings neighbouring the Ag rings are seen, but not interpreted. W. M. LOMER

539.217

10553. Diffusion of Co^{60} in some Ni–Al alloys containing excess vacancies. A. E. BERKOWITZ, F. E. JAUMOT, JR AND F. C. NIX. *Phys. Rev.*, **95**, 1185–9 (*Sept.* 1, 1954).

The aluminium-rich compositions in the δ-phase of Ni–Al exhibit vacancy densities considerably greater than the normal equilibrium concentrations. Measurements were made of the diffusion of Co^{60} in six compositions in the δ-phase of Ni–Al at 1050°C, 1150°C, 1250°C and 1350°C. The diffusion coefficient had a minimum value at the stoichiometric composition. The activation energies had a maximum value at this composition and remained essentially at a lower value for the aluminium-rich alloys. An interpretation of this behaviour in terms of a vacancy mechanism is discussed. A.

539.219

10554. The solid solubility and the diffusion of nickel in germanium. F. VAN DER MAESEN AND J. A. BRENKMAN. *Philips Res. Rep.*, **9**, 225–30 (*June*, 1954).

Nickel produces rapidly diffusing acceptors in germanium, just as copper. Hall and resistivity measurements show the existence of a Ni acceptor level lying 0·23 eV above the valence band. On the basis of this picture the solid solubility between 700 and 900°C is derived from resistivity measurements. From these values and the liquidus curve of the phase diagram Ge–Ni, the distribution coefficients (k) at various temperatures are calculated. The distribution coefficient (k^*) of Ni at the melting point of Ge is calculated at $1{\cdot}8 \times 10^{-6}$ according to a method of Thurmond and Struthers. The diffusion coefficient of Ni in Ge is measured between 700 and 850°C; the activation energy of diffusion is found to be 21 kcal/mole. Annealing of a Ni-saturated Ge sample restores the original resistivity. A.

539.219 : 539.26

10555. On precipitation of metastable centres in solid solutions NaCl–$CaCl_2$. S. MIYAKE AND K. SUZUKI. Note in *Acta Cryst.*, **7**, 514–15 (*July* 20, 1954).

X-ray pictures of single crystals of a solid solution containing two moles % $CaCl_2$ showed diffuse reflections composed of streaks and spots, in addition to the normal Laue spots. The diffuse spots disappeared after heating the crystals to and quenching from 400°C but slowly reappeared during one month at room temperature or 1 hr at 100°C. The observations are interpreted as due to assemblages of thin Ca-rich plate-like precipitates on {111} and {310} planes, each platelet being coherent with the matrix but with unit cell size some multiple of that of the matrix. A. D. LE CLAIRE

539.219.1 : 536.421

10556. On the stability of vertical molten zones. W. HEYWANG AND G. ZIEGLER. Note in *Z. Naturforsch*, **9a**, 561–2 (*June*, 1954) *In German.*

The differential equation to the liquid zone profile is obtained from the condition for equilibrium

between the surface tension and the internal hydrostatic pressure. The maximum stable zone length increases at first linearly with the ingot radius and finally tends to a constant value. J. FRANKS

539.23 : 666

10557. Thin semiconducting layers on glass. A. FISCHER. *Z. Naturforsch.*, **9a,** 508–11 (*June*, 1954) *In German.*

It is of technological value to have highly transparent and highly conductive films on glass substrates. Preparation of such layers is discussed and oxides of tin and indium are found to be suitable. Improved layers consist of $SnO_2 + 1{\cdot}5\%$ Sb_2O_3 and $In_2O_3 + 1{\cdot}5\%$ CdO. C. A. HOGARTH

539.234

10558. Distribution of evaporated films from linear sources. J. G. S. BIRAM. *Atomic Energy Res. Establ.* [*Harwell*] *Rep.* 1394, 8 + vi *pp.* (1954).

The distribution of film thickness obtained from rod-type heaters used in vacuum evaporation is considered, and the conditions under which heater length can be neglected are given. The expressions for this distribution are used to find the absolute thickness at any point on the target when the mass per unit area of film is known. A.

539.234 : 537.311.33

10559. Evaporated multiple layers with semiconductor properties. J. C. M. BRENTANO AND J. D. RICHARDS. Letter in *Phys. Rev.*, **95,** 841–2 (*Aug.* 1, 1954).

Conductivity-temperature curves are given for multiple Pb–Fe layers, formed by depositing *in vacuo* (10^{-6} mm Hg) alternate 2 Å layers of each metal, to a total of ~ 200 layers of each. The multiple layers showed negative temperature coefficients of resistance. It is suggested that films built up in this way may contain both internal lattice boundaries and deficient lattice development, either condition leading to negative cofficients, but in addition even at the low pressures employed, the presence of gas may affect the conduction mechanism. D. G. AVERY

539.234 : 539.26

10560. X-ray investigations on condensed tin films at low temperatures. W. RÜHL. *Z. Phys.*, **138,** *No.* 2, 121–35 (1954) *In German.*

Describes a powder camera by which X-ray photographs may be obtained at temperatures between 20° and 450°K, and in which the metal to be investigated is evaporated *in situ* on to an Al foil. It is found that thin films of Sn and Sn + 13 at. % Cu are well crystallized and not amorphous as had been supposed by some workers. The results are considered in relation to superconductivity and it is found among other things that well crystallized material is not necessary for the occurrence of this phenomenon. J. THEWLIS

539.234 : 539.27

10561. Electron diffraction diagrams of thin metal films at low temperatures. W. BUCKEL. *Z. Phys.*, **138,** *No.* 2, 136–50 (1954) *In German.*

A parallel investigation to that described in preceding abstract. The materials investigated were Sn, Sn + 10 at. % Cu, Ga and W and similar results were obtained. J. THEWLIS

539.26

10562. Small angle X-ray scattering study of imperfections in copper. S. HAYES AND R. SMOLUCHOWSKI. *Appl. sci. Res. B,* **4,** *No.* 1–2, 10–24 (1954).

Upon annealing, the small-angle X-ray scattering in deformed copper first increases and then decreases in the range between 10 and 30 minutes of arc. This result combined with Blin and Guinier's observation [Abstr. 2180 (1952)] that under similar conditions the scattering decreases in the range of $1\frac{1}{2}$ to 7 degrees may be interpreted as an indication of clustering of defects prior to their disappearance. A.

539.26

10563. The effect of lattice distortion on the scattering of X-rays by solid solution crystals. A. GUINIER. *Bull. Soc. Franç. Minéral Crist.*, **77,** 680–710 (*April–June*, 1954) *In French.*

The atoms of a solid solution are generally envisaged as occupying the sites of a perfectly regular lattice; but when the constituent atoms are of different size they will be displaced slightly from the ideal lattice points. A rigorous treatment of the effect on the X-ray diffraction pattern of this "displacement disorder" in real solid solutions being difficult, the simpler case is worked out of equiatomic one-dimensional alloys of various degrees of order in which the atoms are placed side by side along a line without compressing them. The results show that "displacement disorder" can influence both the shape and position of the X-ray lines, although its effect on the low-angle scattering is negligible. Determination of short-range order from low-angle scattering measurements is then unaffected by the presence of displacement disorder. A. D. LE CLAIRE

539.26

10564. X-ray determination of crystallinity in deformed natural rubber. S. C. NYBURG. *Brit. J. appl. Phys.*, **5,** 321–4 (*Sept.*, 1954).

A vulcanized natural rubber was deformed in simple extension and in pure shear and the resulting diminution in X-ray intensity of the "amorphous" halo used as a measure of crystallinity. The effect of mode of deformation and attempts to reach "equilibrium" states by heat treatment at constant deformation are described. The values obtained for simple extension are in accord with those reported by Goppel and not with those of Field. The degree of crystallinity is greater in pure shear than in simple extension at the same principal extension ratio. Corrected values for the orientation of crystalline regions have been obtained and a comparison is made between volume changes and X-ray measurements for simple extension. A.

539.264

10565. Preferred orientations in viscose films. N. DRISCH, P. RODET, J. J. TRILLAT AND C. LEGRAND. *J. Chim. phys.*, **51,** 217–19 (*April*, 1954) *In French.*

These have been investigated with X-ray diffraction. The preferred orientation depends on the degree of polymerization, concentration and thickness of the film. C. TURNER

539.27

10566. Discontinuous tarnish films on copper. E. MENZEL AND W. STÖSSEL. Note in *Naturwissenschaften*, **41**, *No.* 13, 302–3 (1954) *In German.*

The initial stages of copper oxidation were examined with a high temperature microscope. Cu crystals (impurities $< 2\times10^{-5}$) were formed *in vacuo*. At 1 mm Hg of air and 300°c there appeared tarnish films with different interference colours. At 5×10^{-3} mm Hg and 500°c there appeared tiny grains, which assumed a crystalline form after a few minutes. Electron-microscopic examination revealed the presence of only Cu, i.e. the film must have been monatomic. Thus during oxidation, oxygen is reflected or diffused until it can be taken up by the grains. The latter disappeared at 900°c, but at this temperature the tungsten-substrate oxidized at a pressure of 2×10^{-2} mm Hg. This W-film combined with the Cu-film and solidified in the shape of long needles at 650°c. R. A. WEALE

539.27

10567. Crystal habit of magnesium oxide smokes. T. HIBI AND T. OGAWA. *J. Phys. Soc. Japan*, **9**, 627–35 (*July–Aug.*, 1954).

Crystal habit of magnesium oxide smokes was observed by using a magnetic electron microscope. Interference fringes appearing in crystals and the contour forms of crystals in images were observed in order to determine the twin plane and the orientation of the crystals. It was found that there existed many crystals having a (111) twin besides the normal cubic one. Unusual crystals having particular cut sections which may be (111) planes were observed. It was also found that there were many interesting modes of connection of cubic magnesium oxide crystals. A.

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.32

10568. Compressive properties of uranium. N. GROSSMAN AND S. PRICEMAN. *Nucleonics*, **12**, 68–9 (*June*, 1954).

Tests demonstrating the equivalence of the elastic moduli of uranium in tension and compression and determining other elastic properties including shear and bulk moduli, Poisson's ratio and yield strength, are outlined. L. R. SHEPHERD

539.32

10569. An absolute method for the rigidity modulus of gelatin gels. P. R. SAUNDERS AND A. G. WARD. *Rheology Congress Proceedings*, 284–90 [see Abstr. 10588 (1954)].

A cylinder of gelatin set in a glass tube is subjected to shearing stresses by applying a known air pressure to one end of the tube. The rigidity of the gel is calculated from the volume displacement which is measured by causing mercury to move along a calibrated capillary tube. The accuracy, reproducibility and sources of error are discussed. The method is used to investigate the dependence of rigidity on gelatin concentration and on salt content. A.

539.32

10570. A torsional pendulum of low thermal inertia. C. ANG AND C. WERT. Letter in *J. appl. Phys.*, **25**, 1061 (*Aug.*, 1954).

A metal specimen of about 0·03 in. dia., 10 cm long, mounted as the suspension in a counterbalanced inverted torsion pendulum, can be heated at the rate of several hundred degrees a minute by passing a low-voltage a.c. current through it. By this means, transient relaxation effects present in certain Au–Ni alloys shortly after quenching have been observed at about 350°c. J. G. OLDROYD

539.32 : 534.22

Determination of elastic constants of solids from ultrasonic measurements. *See Abstr.* 9988

539.32 : 541.64

10571. Creep of polymethyl methacrylate at low temperature. K. SATO, H. NAKANE, T. HIDESHIMA AND S. IWAYANAGI. *J. Phys. Soc. Japan*, **9**, 413–16 (*May–June*, 1954).

In order to supplement the dynamical investigation of the secondary absorption region of polymethyl methacrylate, which appeared at 20°c in $\frac{1}{2}$ c/s vibration measurement as described in the previous report [Abstr. 6265–6 (1953)] the torsional creep was observed at various temperatures from −50°c to 30°c. Assuming that this polymer is "thermorheologically simple," the master creep curve was constructed, and the activation energy of 30 kcal/mol was obtained. A.

539.37.08

10572. An extensometer for polymeric materials. A. G. H. DIETZ AND F. J. MCGARRY. *Rev. sci. Instrum.*, **25**, 740–5 (*Aug.*, 1954).

A simple, potentiometer-type tensile strain indicator for testing polymers is described in detail. Presenting information which lends itself to automatic recording, the extensometer will detect true, or logarithmic, strains from 0·01 to 200%, at rates from 0·10 to 1000% per minute. In conjunction with other apparatus it can also be used to control the strain rate of the test. Direct calibration under test conditions removes the necessity for temperature compensation. Variables in the design permit considerable flexibility in the desired performance characteristics of the instrument. A.

539.37.08

10573. A sensitive recording extensometer. G. R. HYDE. *J. sci. Instrum.*, **31**, 313–14 (*Sept.*, 1954).

An instrument is described which has been used to obtain load-extension curves on fibres with an accuracy of a few per cent, and with a load limit of 250 mg. The principle of operation is similar to that of the extensometer by Cambridge Instrument Co. Ltd., load being applied at a constant rate by means of a torsion balance while extension is automatically controlled to keep the balance beam horizontal. Load sensitivity is 25 mg/cm along the load axis and a continuous plot of the load-extension curve is obtained from a simple recording mechanism. A.

539.371

10574. Changes in the elastic properties of high polymers during continuous shearing. W. F. O. POLLETT. *Rheology Congress Proceedings*, 85–90 [see Abstr. 10588 (1954)].

From experiments in which Polythene is sheared

between a cone and a flat plate at constant rates of 0·1 to 10·0 sec^{-1}, the amount of elastic shear strain is deduced as a function of the total shear and the temperature, using Weissenberg's theory. The calculated elastic strain is greater than the measured elastic recovery, but shows a similar dependence on shear and on temperature. J. G. OLDROYD

539.373

10575. Slip bands in an α-brass crystal. H. SUZUKI AND F. E. FUJITA. Note in *J. Phys. Soc. Japan*, **9**, 428–30 (*May–June*, 1954).

Electron microscope examination of plastically deformed α-brass crystals, electrolytically etched before deformation, showed wide bands in which had occurred a rotation of the edges of the etch pits by an amount nearly equal to that which would be produced by a shear resulting from the passage of one dislocation over each successive atomic plane. Such slip bands are attributed to Frank–Read sources multiplying in successive planes, rather than on the same plane. A. D. LE CLAIRE

539.374

10576. Dislocation distribution in the region of small plastic deformation. G. LEIBFRIED. *Z. angew. Phys.*, **6**, 251–3 (*June*, 1954) *In German.*

The equilibrium distribution of dislocation rings around a source in a slip plane is considered. The problem is simplified by setting Poisson's ratio zero, making edge and screw dislocation energies equal. The dependences of dislocation density on radius of outermost (locked) ring, and on external stress differ from the well-known linear array only by a numerical factor of $\pi/2$. W. M. LOMER

539.374 : 536.7

10577. Thermodynamics of linear viscoelastic behaviour. A. J. STAVERMAN. *Rheology Congress Proceedings*, 134–9 [see Abstr. 10588 (1954)].

The thermodynamical treatment of linear viscoelastic behaviour of Staverman and Schwarzl [Abstr. 6052–3 (1954)] is extended to include behaviour at different temperatures. A relationship is found between the temperature dependence of the relaxation spectrum and the heat developed during viscoelastic processes which may be used to check the theory experimentally. A.

539.389.3

10578. On relaxation of mechanical stresses. J. KUBÁT. *Rheology Congress Proceedings*, 178–80 [see Abstr. 10588 (1954)] *In German.*

A generalization of Maxwell's stress relaxation law and of Trouten and Rankine's empirical linear relation between stress and the logarithm of the time is proposed in the form of a differential equation, involving two constants, for the rate of change of stress as a function of the time. Support for the equation is based on a statistical model. J. G. OLDROYD

539.389.3

10579. The accurate determination of relaxation spectra. F. SCHWARZL. *Rheology Congress Proceedings*, 197–202 [see Abstr. 10588 (1954)].

Relaxation and retardation spectra can be calculated with increasing accuracy from increasingly higher time derivatives of experimental quantities. A comparison is made between the accuracy obtainable from various types of measurements, such as creep or relaxation measurements, dynamic modulus measurements and measurements of damping. The feasibility of differential measurements is discussed. A.

539.389.3

10580. Elastic relaxation and grain boundary diffusion in cadmium. Y. L. YOUSEF AND R. KAMEL. Letter in *J. appl. Phys.*, **25**, 1064 (*Aug.*, 1954).

For polycrystalline Cd wires there is at 100°C a sharp maximum in the internal friction (measured at ~ 50 c/s) and a relaxation of the Young's modulus. Since both these are absent in single crystal wires, they are to be associated with some property of the grain boundary. According to the authors this is assumed to be grain boundary diffusion.

A. D. LE CLAIRE

539.4

10581. The temperature dependence of the critical shear stress and of work-hardening of metal crystals. A. SEEGER. Letter in *Phil. Mag.*, **45**, 771–3 (*July*, 1954).

Calculations based on a simple model predict a critical temperature below which the critical shear stress increases linearly with decreasing temperature and above which it is practically constant, in accordance with experimental observations on Zn, Cd, Mg and Bi. An explanation also appears of the smaller dependence on temperature of the work hardening coefficient in the easy glide region than at larger strains.

A. D. LE CLAIRE

539.4 : 539.374

10582. The strength and plastic properties of needle-shaped NaCl crystals. Z. GYULAI. *Z. Phys.*, **138**, *No.* 3–4, 317–21 (1954) *In German.*

A method of preparing needle-shaped NaCl crystals 0·5–10 μ thick and 1–12 mm long is described. The strength of the thinner needles approaches the theoretical value. Plastically deformed crystals exhibit slip lines, and straighten on heating. J. FRANKS

539.4.016.3 : 536.7

10583. On the energetics of the hardening stages of Cu–Al. U. DEHLINGER AND H. KNAPP. *Appl. sci. Res. A*, **4**, *No.* 4, 231–6 (1954) *In German.*

The energy released and absorbed as the temperature was raised was measured for Al containing 4·8% wt. Cu from the quenched condition. Energy is absorbed as the Preston–Guinier zones dissolve and is released as θ′ $CuAl_2$ is formed, absorbed as this redissolves and released as θ $CuAl_2$ forms. Free energy curves for various conditions of the alloy are deduced. W. M. LOMER

539.42 : 532.613.2

10584. Studies on the wetting effect and the surface tension of solids. A formula for determining surface tension of solids. M. SATO. *Proc. Japan Acad.*, **30**, 193–8 (*March*, 1954).

Taylor's theory of elementary fracture [see Abstr. 1098 (1948)] assumes that Young's modulus applies

right up to fracture, the energy per unit area released at fracture being equated to surface tension. The present work derives an equation in terms of breaking stress instead of modulus and fracture distance, it being assumed that the effect of wetting on breaking stress will be the same as the wetting effect on the modulus. The surface tension in this work is, of course, the solid wetting-liquid interfacial tension.

T. C. TOYE

539.434

10585. Creep of metals under pulses of constant stress. A. J. KENNEDY. *Rheology Congress Proceedings*, 260–5 [see Abstr. 10588 (1954)].

Interrupted creep tests on annealed Cu and Pb support a theory that a crystal contains zones where complete recovery has taken place, while the remainder behaves as if unloading had not occurred. Softening during interruptions can be so marked that repeated stress pulses may cause greater creep strain than a continuous application of the same stress for the same total test time. J. G. OLDROYD

539.434

10586. On the transient flow of metals at high temperatures. P. FELTHAM. *Rheology Congress Proceedings*, 266–73 [see Abstr. 10588 (1954)].

Creep experiments on a plain 0·23% C steel at 950–1350°C lead to the Andrade (β-flow) law with a coefficient $\beta = \beta_0 \exp(-H/kT) \sinh(q\sigma/kT)$, where β_0, H, k, q are constants, T is the temperature, and σ the stress. J. G. OLDROYD

539.434

10587. A graphical method of analysing creep curves. A. J. ELLEMAN. Letter in *Nature* [*London*] **174,** 138–9 (*July* 17, 1954).

Refers to the analysis in terms of a series of Voigt elements characterized by a spectrum of relaxation times. By assuming a Gaussian shaped spectrum the method provides the three characteristic constants defining the creep properties, viz. the equilibrium strain for a given stress, the variance of the relaxation spectrum and the modal relaxation time.

A. D. LE CLAIRE

539.5

10588. Proceedings of the Second International Congress on Rheology. Edited by V. G. W. HARRISON. *London: Butterworths Scientific Publications* (1954) ix + 451 *pp.*

Proceedings of the Congress held in Oxford during 26th–31st July, 1953. · Reported in *Nature* [*London*] **172,** 487 (*Sept.* 12, 1953). For abstracts of some of the papers, see Abstr. 9959–60, 9963–4, 9966, 9996, 10569, 10574, 10577–9, 10585–6, 10589–90, 10594 (1954).

539.5 : 536.7

10589. The thermodynamics of volume flow. R. O. DAVIES. *Rheology Congress Proceedings*, 171–7 [see Abstr. 10588 (1954)].

An irreversible thermodynamic theory, in which the state of the material at any instant is defined by the pressure, the temperature, and a third (ordering) variable, leads to a linear relation between the pressure, the dilatation, and their time derivatives, as the rheological equation of state for volume changes without shear. Such an equation explains approximately the behaviour of certain glasses, high polymers, etc. J. G. OLDROYD

539.5 : 539.537

10590. A mathematical interpretation of some experiments on plastics and rubberlike materials. E. VOLTERRA. *Rheology Congress Proceedings*, 73–8 [see Abstr. 10588 (1954)].

Experiments on effects of impact loading on plastics and rubber-like materials are briefly reviewed. The derivation of dynamic stress/strain curves is discussed. A mathematical interpretation of the results is presented in terms of heredity of the first degree. A.

539.531

10591. Concerning the measurement of the dynamic hardness of metals. S. B. AĪNBINDER. *Latv. PSR Zināt. Akad. Vēstis*, **1952,** *No.* 8, 127–36. *In Russian.*

The definition of dynamic hardness of a series of metals by a new method is examined, and it is claimed that the relationship between this hardness and the ratio d/D (indentation), and numerical results obtained by other authors are incorrect for this series (steels, rolled and annealed Cu, Zn). A qualitative explanation is given of the dynamic curve in metals in terms of plastic flow. W. BARDSLEY

539.533

10592. Hardening of Pd by cathodic hydrogen. T. SUGENO AND M. KOWAKA. Letter in *J. appl. Phys.*, **25,** 1063–4 (*Aug.*, 1954).

Measurements of the hardness as a function of time of charging with H_2 (at constant current density) and of time of discharging of previously hardened samples, indicate a fundamental difference in the mechanisms of H_2 hardening in the α- and the β-phases. A. D. LE CLAIRE

539.61

10593. Adhesion of metals and their stability under complex stresses. S. B. AĪNBINDER. *Latv. PSR Zināt. Akad. Vēstis*, **1953,** *No.* 4, 113–16. *In Russian.*

A brief account of experiments, investigating adhesion of two metal surfaces after forced deformation by crushing, pulling and torsion. The required deformation, before flow and subsequent adhesion occur, decreases when the surfaces are degreased and polished; in the extreme case of pre-heating in vacuum less than 100 g load is sufficient to produce adhesion. Where metals are pulled apart, adhesion is delayed and the test pieces go brittle. Appearance of fissures and closing-up of these under adhesion are also investigated. No quantitative data are given.

A. LANDMAN

539.621 : 532.516

10594. A theory of grease lubrication of a slider bearing. A. A. MILNE. *Rheology Congress Proceedings*, 427–36 [see Abstr. 10588 (1954)].

The theory of flow of a Bingham plastic solid in a slider bearing is considered. In parts of the grease film the yield point may not be reached, so that the local viscosity is effectively infinite. Solid cores in which the velocity gradient vanishes have been observed, as predicted, in plastic solid greases, by using transparent models. J. G. OLDROYD

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.126

10595. Free radicals in flames and explosions. G. PANNETIER. *Cahiers de Phys., No.* 50, 54–84 (*July*, 1954) *In French.*

The spectrometric detection of free radicals in flames and explosions is reviewed and discussed. The burning of hydrogen in oxygen, the combustion of hydrocarbons, nitrogen and halogens in flames, and the combustion of carbon monoxide are considered. The reactions in which free radicals produced by combustion can take part are discussed.

A. J. MEE

541.127

10596. Note on the relation between reaction rate, affinity and Van't Hoff's law. M. BONNEMAY. *J. Rech. Cent. Nat. Rech. Sci.*, **5**, 305–7 (*March*, 1954) *In French.*

Affinity and reaction rate are proportional only near the reaction equilibrium. A more general relation is derived, of which van't Hoff's law is an approximation. The formula is applied to various reactions. A. J. TAYLOR

541.127

10597. Kinetics of oxidation of ammonia by nitric oxide. H. WISE AND M. F. FRECH. Letter in *J. chem. Phys.*, **22**, 1463–4 (*Aug.*, 1954).

The reaction was studied at 990–1150°K, progress being followed by total pressure change. The initial rate of pressure change was given by $dP/dt = k \cdot p_{NH_3} \cdot (p_{NO})^{\frac{1}{2}}$ with $k = 1 \cdot 1 \times 10^{11} \exp(-54\,700/RT)$ $mm^{-1/2}\,sec^{-1}$. Apparently NH is formed before NH_2, in contrast to the $NH_3 + O_2$ reaction.

J. HAWGOOD

541.127

10598. An infrared study of the BF_3–BCl_3 reaction. R. E. NIGHTINGALE AND B. CRAWFORD, JR. Letter in *J. chem. Phys.*, **22**, 1468 (*Aug.*, 1954).

The reaction of these compounds forming both mixed boron halides was studied kinetically. The change in intensity of the absorption bands was followed with a spectrometer. The reaction does not go to completion, as the reverse reaction occurs also. The half-life of the reaction is estimated to be about 10 minutes, which means a second-order rate constant of 5×10^3 $cm^3\,mole^{-1}\,sec^{-1}$. From this slow rate an intermediate bridge compound is thought unlikely.

A. J. TAYLOR

541.128

10599. An automatic system for the study of catalytic reactions involving gases. K. W. HANNAH, M. J. JONCICH AND N. HACKERMAN. *Rev. sci. Instrum.*, **25**, 636–9 (*July*, 1954).

An automatic system, employing a metal bellows, designed and constructed for the purpose of studying the catalytic combination of hydrogen and oxygen on a submerged catalyst in a stirred solution. The reaction was carried out under conditions of constant temperature, pressure and volume. This system can be used to study the reaction for unlimited lengths of time; it is completely automatic, and can be used to study reaction rates quantitatively. It can be modified for the study of other reactions. A.

541.128 : 542.941.7

10600. Homogeneous activation of molecular hydrogen by cupric acetate. J. HALPERN AND R. G. DAKERS. Letter in *J. chem. Phys.*, **22**, 1272–3 (*July*, 1954).

Under certain conditions molecular H_2 can be activated homogeneously by solutions of cupric acetate. If H_2 is passed into an aqueous solution of cupric acetate the following reaction occurs: $2CuAc_2 + H_2 + H_2O \rightarrow Cu_2O + 4HAc$. The reaction goes to completion if H_2 is in excess. The kinetics of the reaction were studied over the range 80–140° and 6·8–34 atm. H_2. The rate constant is second-order and is independent of the concentration of H_2 and of cupric acetate, and of the pH of the solution. The reaction is homogeneous, being independent of the surface area of the stainless-steel reaction vessel and of the Cu_2O product. The activation energy is 24·2 kcal. per g. mol. and the entropy of activation at 100° is −6·5 e.u. The kinetic results suggest that the rate-determining step is a homogeneous bimolecular process involving the formation of a complex between a molecule of H_2 and a molecule of cupric acetate. The H_2 becomes activated in this step. Cupric acetate should be able to act as a catalyst for the homogeneous hydrogenation of other compounds and it has been shown that when a reducible substrate, e.g. $Cr_2O_7^{--}$, is present in the solution with the cupric acetate it is preferentially hydrogenated. A. J. MEE

ELECTROCHEMISTRY 541.13

541.13 : 536.7

10601. Thermodynamics of the electrochemical process. T. G. OWE BERG. *J. Chim. phys.*, **51**, 225–32 (*May*, 1954) *In French.*

The second law of thermodynamics, as extended to irreversible processes, is applied to electrolytic conduction and to the potential (contact, transference and diffusion) between two solutions in contact with each other. The formulae obtained are supported by agreement between calculated and known experimental data. 22 refs. H. H. HODGSON

541.135.4

10602. Conduction by oxide ion in the solid state. J. L. WEININGER AND P. D. ZEMANY. Letter in *J. chem. Phys.*, **22**, 1469–70 (*Aug.*, 1954).

It has been shown experimentally that the $O^=$ ion acts as a carrier when current passes through a Nernst glower, composed of about 85 mole % ZrO_2 and about 15 mole % Y_2O_3. The rate of oxygen production was measured spectrometrically and accounted for amounts varying between 7 and 80% of the current: the amounts decreased with increasing temperature. CO_2 was also evolved. A. J. TAYLOR

541.135.5

10603. Derivation of the equilibrium potential of an electrode as a function of its surface condition. M. Bonnemay. *J. Rech. Cent. Nat. Rech. Sci.*, **5**, 392–5 (*June*, 1954) *In French.*

A generalization of Haïssinsky's hypothesis of the existence of active centres on an electrode, based on a consideration of centres of ionization and discharge, has led to a more precise interpretation of the mechanism of poisoning of an electrode, and has enabled the derivation of the equilibrium potential as a function of the superficial condition. Modifications of the forces between electrode and ions in solution, due to deposition of different substances at the active centres, are excluded from the present treatment. H. H. HODGSON

PHOTOCHEMISTRY . RADIATION CHEMISTRY
541.14/.15

541.14 : 535.343.2

10604. The absorption spectrum of photochemical reaction products of silverbromide with silversulphide at low temperatures. O. Stasiw. *Z. Phys.*, **138**, *No.* 3–4, 246–50 (1954) *In German.*

Photochemical reactions in ionic lattices or crystals in which some alien matter is enclosed involve electronic and ionic processes and interactions with the lattice faults. In order to investigate this the concentrations in the crystal and the properties of the perturbations must be accurately known. To this end AgBr with a small amount of Ag_2S was investigated. The absorption spectrum was taken of such mixed crystals which were prepared by rapid cooling after mixing at high temperature. At 90°K a sharp absorption band was found which did not appear at higher temperatures. After the decrease in temperature some association takes place between the added ions and some positive lattice faults: this also causes the spectrum to shift to higher frequencies. After irradiation with light of 436 μ a new absorption region appears which must be due to increasing interaction of the S ions with crystal faults. Through long irradiation at −190°c with light of longer wavelength a new absorption due to stable colloidal centres could be observed. A. J. TAYLOR

541.15

10605. Decomposition of water by polonium alpha particles. M. C. Anta and M. Lefort. *J. Chim. phys.*, **51**, 29–32 (*Jan.*, 1954) *In French.*

Previously reported discrepancies between the chemical effects of α-particles from Po and those from Rn are now shown to be due to impurities introduced in the Po solutions. By deposition on a gold anode, pure polonium has been separated. Results from the decomposition of water by the α-particles from this source are the same as those for α-particles from radon. C. B. ALLSOPP

541.15

10606. Reduction of ceric salts by α particles from polonium prepared by anodic deposition. M. C. Anta and M. Haïssinsky. Letter in *J. Chim. phys.*, **51**, 33–4 (*Jan.*, 1954) *In French.*

When α-particles from polonium prepared by anodic deposition (preceding abstract) are used, the yield in the reduction of ceric salts agrees within experimental error with that obtained with α-particles from radon. The radiation chemistry of cerium solutions appears to be much more sensitive to impurities than that of iron solutions. C. B. ALLSOPP

541.15

10607. Decomposition of pure water and of solutions of organic compounds by pile radiation. I. Experimental study. M. Rolin. *J. Chim. phys.*, **51**, 35–46 (*Feb.*, 1954) *In French.*

Analyses of the gases produced by irradiation in the Chatillon pile of solutions of organic compounds (formic, acetic, oxalic and benzoic acids, methyl and ethyl alcohols and glycol, phenol, benzene, urea) are compared with those obtained from pure water, the radiation doses being measured with ferrous sulphate solutions. For a given dose, the production of oxygen is higher than that from water for the organic solutions and less for the ferrous solutions. The increase is most marked with aliphatic compounds and less obvious for the aromatic ones. Gases condensed in liquid N_2 were identified in some cases by measurements of sublimation pressure: they indicate decarboxylation of aliphatic and aromatic acids. Urea yields CO_2 but no CO. By filtering the radiation with bismuth or cadmium, it is shown that γ-radiation predominates in the oxidation of ferrous ion while decomposition of water is mainly caused by neutrons. C. B. ALLSOPP

541.15

10608. Nature of the primary products in the radiolysis of water. F. Fiquet and A. Bernas. *J. Chim. phys.*, **51**, 47–51 (*Feb.*, 1954) *In French.*

Two mechanisms for the primary radiolysis of water have been proposed, viz. (1) $H_2O \rightarrow H + OH$, (2) $2H_2O \rightarrow H_2 + 2OH$. The radiation-induced polymerizations of acrylonitrile, methacrylonitrile and methyl methacrylate in solution in heavy water have been investigated, the products being analysed by infrared spectroscopy. No evidence for the presence of free atomic D was obtained. These experiments therefore contra-indicate mechanism (1). C. B. ALLSOPP

541.15

10609. Radiochemical degradation of high polymers. I. Theoretical study of the variation of mean molecular weights, averaged over number, over weight, found by viscosity and of *Z* type. Measurement of the number of chain breaks. J. Durup. *J. Chim. phys.*, **51**, 64–73 (*Feb.*, 1954) *In French.*

The breakage of high polymers by ionizing radiation has been studied mainly by viscosimetric methods, but other quantities, like osmotic pressure, rate of sedimentation, diffusion constants, etc., vary with the size of the molecule. These variations were investigated. It was assumed that the molecular weight distribution is natural, and that the probability of breaking is the same for each chain link. As a variable was chosen the number of chain breaks instead of the time. Relations are derived for the

different mean molecular weights and their variations. The results are tabulated. Experimental values obtained for polystyrene are used as example.

A. J. TAYLOR

541.15

10610. Chemical form of phosphorus-32 produced in aluminium by bombardment with nitrogen. G. A. CHACKETT AND K. F. CHACKETT. Letter in *Nature* [*London*] **174,** 232–3 (*July* 31, 1954).

Al foils bombarded by high-energy N^{14} ions were dissolved in NaOH solution in absence of air. Two-thirds of the P^{32} activity produced in the nuclear reactions appeared as phosphine and the rest remained in solution, probably as hypophosphite. A negligible amount appeared as phosphate. The meaning of these results is discussed and it is suggested that the P^{32} atoms may all be held in the Al lattice in a very low, or even zero, charge state. J. H. FREMLIN

DISPERSIONS . COLLOIDS . ADSORPTION 541.18

541.183

10611. Statistical interpretation of Freundlich's isotherm in the region of very weak concentrations. J. DANON AND A. A. L. ZAMITH. *J. Chim. phys.*, **51,** 260–2 (*May*, 1954) *In French.*

It is shown that Halsey and Taylor's statistical derivation of Freundlich's isotherm [Abstr. 3714 (1947)] is valid, for weak concentrations, as an approximation which is equivalent to neglecting the variation of the molar configurational entropy with the degree of covering of the adsorbing surface.

E. H. SONDHEIMER

541.183

10612. Some aspects of pair interactions for a linear array of sites, as applied to adsorption problems. R. F. STEINER. Letter in *J. chem. Phys.*, **22,** 1458–9 (*Aug.*, 1954).

Theoretical. The effect of pair interactions between both first and second nearest neighbours, upon adsorption by a linear array of sites, is considered and equations are derived which allow the computation of the complete adsorption isotherm. It is suggested that the equations should prove useful in the interpretation of experimental data on the binding of ions by nucleic acid and other polyelectrolytes.

J. IBALL

541.183.022

10613. Study of monomolecular films of high polymers. J. JAFFE. *J. Chim. phys.*, **51,** 243–9 (*May*, 1954) *In French.*

The surface tensions of four cellulose acetate fractions of different molecular weights were measured by Guastalla's [*J. Chim. phys.*, **48,** 622 (1951)] method. This method allows very accurate results (within 0·0005 dynes/cm). The molecular weights were found from these with the use of a relation also derived by Guastalla, which involves van der Waals's equation. The molecular weights were verified by two other methods: by comparison with fractions with known molecular weight and by the viscosimetric method. Average interatomic distances were calculated, which were found to be of a reasonable order. A. J. TAYLOR

CHEMICAL STRUCTURE 541.2/.6

541.42 : 532.13

10614. Viscosity and electroviscous effect of emulsions. M. VAN DER WAARDEN. *J. Colloid Sci.*, **9,** 215–22 (*June*, 1954).

Measurements of viscosity and of light scattering were made on uniform oil-in-water emulsions of 5–30% concentration by weight, the amount of emulsifier being varied between 5 and 35% of the oil phase. Particle diameters calculated from the two types of experiment differ by an approximately constant amount in all the emulsions. The oil droplets behave in flow as if they were enveloped by a rigid layer of 30–35 Å thickness, a consequence of a uniform electric charge density on the surface of the droplets. J. G. OLDROYD

541.5

10615. On the valence frequencies of the group $-N=O$ in nitroso compounds. W. LÜTTKE. *J. Phys. Radium*, **15,** 633–5 (*July–Aug.–Sept.*, 1954) *In French.*

Nitroso compounds usually crystallize in colourless crystals consisting of double molecules, but their solutions and vapours are strongly coloured and there the molecules are monomers. In order to investigate this phenomenon the frequencies of the N . O valence vibration was accurately determined for nitrosobenzene and a few other compounds. The method followed was the spectroscopic registration of the changes in the spectra during oxidation. The N . O valence vibration of nitroso-benzene was determined at 1517 cm^{-1} in the vapour and 1506 cm^{-1} in the liquid. A band at 1108 cm^{-1}, which disappeared during oxidation, was attributed to a vibration of the ring coupled to that of the nitroso group. The dimer spectra showed many more bands than those of the monomers: the symmetry of the dimer molecules must be rather low. A relation, which was found to exist between the valence frequency and the nuclear distance of the NO group, is depicted in a graph. The NO bond in the monomer was found to be practically a double bond, but in the dimer it had much more single bond character. A. J. TAYLOR

541.57

10616. On the stability of metallo-organic compounds. II. H. H. JAFFÉ. Letter in *J. chem. Phys.*, **22,** 1462–3 (*Aug.*, 1954).

For Pt I, see Abstr. 2797 (1953). Calculations have been extended to unsaturated organic radicals and metals of other than the 2nd and 3rd periods. Bond energies decrease with increasing Z inside any group. Three factors affect comparative strengths of bonds with different radicals; hybridization of the C atom,

π-electron resonance energy, and rearrangement energy of the radicals. The first two cause unsaturated radicals to form stronger bonds than aliphatic radicals, while the third probably does also, though difficult to estimate. J. HAWGOOD

541.62

10617. Isomerism of monosubstituted derivatives of cyclohexane. M. LARNAUDIE. *J. Phys. Radium*, **15**, 650–1 (*July–Aug.–Sept.*, 1954) *In French.*

As cyclohexane has the symmetry D_{3d}, the H atoms are not all equivalent and there are two isomeric monosubstituted cyclohexanes possible: of type ε, with the axis between the C atom and the substituent parallel to the threefold axis, and of type χ. As only one monodeuterocyclohexane is known, this was prepared and its Raman and infrared spectra were taken: the C–D valence vibration was investigated. The C–D bond in the vapour spectrum has three components, one of which (at 2146 cm^{-1}) is parallel, the others being perpendicular. This proves the substitution to be of χ type. Similar spectra were taken of halogen-substituted cyclohexane (liquid and vapour): all bonds found in the vapour spectrum were due to the χ-isomer. This was also the case with methylcyclohexane. The χ-isomer is always dominant, but the ε-isomer probably exists in the liquid phases and to some extent in the vapour of the deuterated and chlorinated compounds. A. J. TAYLOR

541.651

10618. Spectrophotometric study of the isomerization of various thermochromic spirans. O. CHAUDÉ. *Cahiers de Phys., No.* 50, 17–53 (*July*, 1954) *In French.*

The reversible increase in intensity of colour with change of temperature of certain spiran-type molecules has been investigated spectrophotometrically. The basis of the thermochromism is supposed to be an equilibrium between the colourless "closed" spiran form and an "open" coloured ionic form. The variation of the magnitude of the thermodynamic functions of the equilibrium with change of solvent and for different groupings introduced into the spiran molecule has been investigated. The equilibrium can be modified by the action of light; visible radiation absorbed by the open form assists its conversion into the closed form, and the ultraviolet radiation absorbed by the closed form assists its change into the open form. The results agree with the assignment of a bipolar structure to the open form, the magnitude of the charges being dependent upon the groups attached to the spiran skeleton. There should therefore be a change in the dipole moment of the compound in passing from the closed to the open form, but this has not been detected practically owing to experimental difficulties. A. J. MEE

541.67

10619. Magneto-chemical study of organic compounds of fluorine. R. PERCEAU. *C.R. Acad. Sci.* [*Paris*] **239**, 170–1 (*July* 12, 1954) *In French.*

A study of perfluorated derivatives shows that the additivity law is obeyed. The atomic susceptibility is determined as $-5{\cdot}82\times10^{-6}$ c.g.s.; the atomic increment of fluorine is the same in mono- or polyfluorated compounds. J. JACOBS

CHEMICAL ANALYSIS 543/545

545.81

10620. Measurement of the concentration of very dilute solutions of coloured substances with the aid of a differential absorptiometer. T. G. MEĬSTER. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **17**, *No.* 6, 733–5 (1953) *In Russian.*

The circuit diagram for a differential absorptiometer with a vacuum photocell and a single-stage d.c. amplifier with a gain of $\sim10^4$ is shown, in which the galvanometer reading is proportional to the difference between the light intensity transmitted by the solution under investigation and by pure solvent. Optical densities of up to 0·05 or higher can be measured. The application of the instrument to measurements of phosphate concentration, as the ammonium phosphomolybdate complex, is reported. R. C. MURRAY

545.82

10621. Absorption spectra and equilibrium. N. P. KOMAR'. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **17**, *No.* 6, 675–80 (1953) *In Russian.*

Theoretical. The applicability of Ostromyslensky's (1911) spectrophotometric variant of physico-chemical analysis to determination of the composition of equilibrium mixtures of, e.g. BOH + HR, is discussed, and formulae are derived for optical densities as functions of the concentrations and extinction coefficients of the individual components, and of their dissociation constants. R. C. MURRAY

545.82 : 535.375.5

10622. Improved method of molecular analysis by Raman spectra. P. A. BAZHULIN AND G. V. PEREGUDOV. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **17**, *No.* 5, 617–20 (1953) *In Russian.*

The solution under investigation, and a reference solution, are placed in two separate cells disposed parallel to one another and symmetrically with respect to two mercury u.v. lamps, illuminating the cells from both sides. The light scattered from both cells is collected by means of a rotating prism and lens system, and produces on the spectrographic film two images near to one another, of the Raman spectra of the two liquids. The method saves about 6–8 hours in making a complete analysis of a mixture of organic substances. R. C. MURRAY

545.822

10623. Determination of the intensity of infrared absorption bands. F. OSWALD. *Z. Electrochem.*, **58**, *No.* 5, 345–7 (1954) *In German.*

Chemical analysis by measurement of the optical density at the maximum of a band may involve a correction for finite slit width which sometimes amounts to 20%. Instead, one may use the total intensity of a band; methods of determining this by planimeter integration of an absorption curve are described, with a discussion of the correction necessary when the curve is not on a uniform wavenumber scale. G. F. LOTHIAN

545.823

10624. A rapid spectrographic method for the determination of beryllium in air dust. F. P. LANDIS AND M. C. COONS. *Appl. Spectrosc.*, **8**, 71–5 (*May*, 1954).

A method has been developed for the determination of beryllium in air dust samples at the rate of 11 man-minutes per sample. The method involves the use of a small filter paper sample which is inserted into a cupped graphite electrode and arced in a conventional d.c. arc. Certain treatments are necessary to ensure optimum excitation of the sample, including the addition of a barium chloride carrier and internal standard. The method is sensitive to 0·002 μg of beryllium on the filter paper, and the range of analysis extends to 0·1 μg. The accuracy of the method is about $\pm 30\%$ of the amount of beryllium present. A.

CRYSTALLOGRAPHY 548

548.0 : 535.343.2 : 537.311.32

10625. Optical and electrical properties of LiF, irradiated with X-rays at −190°C. C. J. DELBECQ, P. PRINGSHEIM AND P. H. YUSTER. *Z. Phys.*, **138**, *No.* 3–4, 266–75 (1954) *In German.*

Experiments are made to obtain correlation between absorption spectra, thermoluminescence and electrical conductivity for LiF coloured by X-rays at −190°C. Current and luminescence glow peaks occur at the same temperatures (−161, −133, −83, −20 and +14°C). The *F*-absorption (242 mμ) shows a partial thermal bleaching between −160 and −120 while the 340 mμ band is almost completely bleached in this range, the derived change with temperature showing maxima in agreement with those for thermoluminescence. Theoretical discussion of the results is included. G. F. J. GARLICK

548.5

10626. Study on the crystallization process of polished layers of metals by electron diffraction and microscopy. K. NONAKA AND K. KOHRA. *J. Phys. Soc. Japan*, **9**, 512–20 (*July–Aug.*, 1954).

Polished layers, the so-called Beilby layers, of Cu, Ni and Au are heated in vacuum or, for Ni, in hydrogen atmosphere, and the process of crystal growth is studied by electron diffraction and electron microscopy. The crystallization curves at various temperatures are also obtained. Above a certain temperature, for each metal, the crystallization goes on pretty rapidly: for instance, polished surfaces of Cu, Ni and Au crystallize in one hour at 60°C, 250°C and below 200°C, respectively. The crystallized surfaces consist mostly of Cu_2O and of NiO for Cu and Ni surfaces respectively, and exclusively of metallic Au for Au surface. They are accompanied by weak fibre structures, which are more remarkable by the heating at lower temperatures. When the polished specimen of Ni is heated in hydrogen atmosphere, the number of the nuclei of crystallization is smaller than for specimens heated in vacuum. A.

548.5 : 535.417

10627. On the observation of growth patterns of crystals by two-beam interference methods. G. NOMARSKI AND A. R. WEILL. *Bull. Soc. Franç. Minéral Crist.*, **77**, 840–68 (*April–June*, 1954) *In French.*

A somewhat detailed description of the underlying principle and methods of observation of micro-reliefs on reflecting surfaces by interference methods using polarized light. The new interference microscope arrangement with quartz biprism demonstrated at the 1952 exhibition of the Société française de Physique by Nomarski is shown schematically and other arrangements for the production of localized and non-localized fringes are discussed. Results obtained in the study of the untreated natural surfaces of SiC crystals by the methods described are illustrated and attention is directed to them to show that all the now known characteristic growth patterns may be observed directly. S. WEINTROUB

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

10628. A crystal lattice model. R. HILSCH. *Z. Phys.*, **138**, *No.* 3–4, 432–5 (1954) *In German.*

Several models representing crystal lattices have been suggested previously but none can be used for perturbed or polar lattices. To this end a new model was designed, made up mainly of magnets. It is described how the various phenomena can be demonstrated in the model. Crystals of alkali halides are represented as examples. A. J. TAYLOR

548.7

10629. Lattice dynamics of ice and a case of diffuse X-ray scattering. E. FORSLIND. *K. Tekn. Högsk. Avhandl.*, *No.* 96, 42 *pp.* (1954).

Part I consists of a long derivation of the lattice dynamics of ice, from which vibration spectra for modes propagated along the *a*-axis and for modes propagated along the *c*-axis are deduced. In Part II the X-ray scattering power is calculated on three lines through the reciprocal-lattice point 10; 0.

A. R. STOKES

548.7

10630. A method of treating the zero-point vibration of the crystal of lighter molecules. A. YOSHIMORI AND T. MATSUBARA. *J. Phys. Soc. Japan*, **9**, 465–71 (*July–Aug.*, 1954).

A method of treating the zero point vibration of a molecular crystal of lighter elements, in which the vibrational amplitude is fairly large but the anharmonicity is small, is described. This consists of employing the Ritz variational method, assuming the wave-function of the same form as that for an

assembly of harmonic oscillators. The correlation between the positions of the molecules can be taken into account to some extent by this method. Two approximate methods are employed; one is essentially the usual method of supposing a harmonic vibrational potential and the other the method of supposing an anharmonic potential. Numerical calculations are carried out for solid neon, and reasonable results are obtained. A.

548.7 : 536.21

10631. The lattice thermal conductivity of silver-palladium alloys at low temperatures. W. R. G. Kemp, P. G. Klemens, A. K. Sreedhar and G. K. White. Letter in *Proc. Phys. Soc.* [*London*] *A*, **67**, 728–30 (*Aug.*, 1954).

The lattice component of the thermal conductivity of a series of Ag–Pd alloys of varying composition in the range 2–160°K was computed from the measured total conductivity. Below 12°K it was found to be proportional to T^2, as expected if the scattering of phonons is mainly due to the conduction electrons. The results indicate that the latter interact with both longitudinal and transverse waves, though probably less strongly with the transverse waves. T. P. BRODY

548.7

10632. The study of order-disorder changes in binary alloys. IV. Study of the alloy Cu–Pt. G. Fournet. *Bull. Soc. Franç. Minéral. Crist.*, **77**, 711–24 (*April–June*, 1954) *In French.*

The details of a calculation previously reported in brief [Abstr. 3718 (1953)]. By taking the values $W(r_1) = 1{\cdot}05\times10^{-13}$ and $W(r_2) = 1{\cdot}72\times10^{-13}$ erg excellent agreement between the theoretical and experimental long-range order *v.* temperature relations is obtained. The same values of W account satisfactorily also for the observed degree of short-range order. A. D. LE CLAIRE

548.7

10633. Formation energy of superlattice in Ni_3Fe. II. Kinetics of the superlattice in the stage of local ordering. S. Iida. *J. Phys. Soc. Japan*, **9**, 346–54 (*May–June*, 1954).

For Pt I, see Abstr. 8563 (1952). The change of the internal energy of Ni_3Fe superlattice during cooling processes was studied by specific heat measurement for various rates of cooling. After eliminating the part of the internal energy due to magnetic transformation, it was shown that the formation of local order starts already at 600°C on cooling, and its rate attains a maximum at 520°C, decreasing to zero at about 400°C. The specific heat curves on cooling do not show any anomaly at 500°C, which is critical temperature for the long-range order. The formation rate of local order at steady temperature annealing was also studied by keeping the specimen at 510°C and observing the heat of evolution directly. It was confirmed that the rate of local order formation is large enough to be observed at this temperature. It decreases monotonically and becomes zero after about five hours annealing. These data are all consistent with the previous assumption that one of the two steps in the formation of superlattice in Ni_3Fe at 490°C is the development of local order which has no critical temperature. A.

548.7

10634. The exchange interaction between valency electrons and inner electrons in crystals (the (*s–d*)-exchange model for transition metals). S. V. Vonsovskiĭ and E. A. Turov. *Zh. éksper. teor. Fiz.*, **24**, *No.* 4, 419–28 (1953) *In Russian.*

The many-electron theory of transition metals is used to construct a (*s–d*)-exchange model which takes into account the active part played in the physical properties of the crystals of transition elements by the former valency and inner electrons of the incomplete atomic shells. An expression is obtained for the energy operator of the system. Under certain assumptions, the eigenvalues of this operator yield two branches of the energy spectrum of the system, in correspondence with elementary excitations of the Bose type (ferromagnons) and Fermi type (conductivity electrons). A non-diagonal addition to the energy operator describes the interaction processes (collisions) between the ferromagnons and conductivity electrons. F. LACHMAN

548.7

10635. Single electron examination of the motion of an electron in a disturbed crystal. T. I. Liberberg and K. B. Tolpygo. *Zh. éksper. teor. Fiz.*, **26**, *No.* 1, 35–41 (1954) *In Russian.*

A theoretical paper examining the additional motion from the introduction into a dielectric of an electron (hole) in the field of any defect by single electron equations (strong bond approximation). Gives information about the deformation of atoms (ions) by the field of the additional charge. Uses Hartree's approximation for a solution in particular derivatives for single particles which proves useful. Examines the extreme cases of very narrow and very wide potential wells produced by defects.

W. BARDSLEY

548.7

10636. On the variational calculation of the activation energy of dislocation. A. Sugiyama. *J. Phys. Soc. Japan*, **9**, 460–4 (*July–Aug.*, 1954).

The formulae of the activation energy of a dislocation trapped in a potential trough are solved by a variational method, which relates closely to the usual Lagrangian form in analytical dynamics. To compare them with the approximate solution of Cottrel, numerical calculations are carried out in the particular case where the anchored force is due to the interaction with Cottrel's atmosphere. Consequently, the elegant agreement between the observed and Cottrel's approximate solution is lost. A.

548.7 : 539.11

10637. Radiation disarrangement of crystals. J. S. Koehler and F. Seitz. *Z. Phys.*, **138**, *No.* 3–4, 238–45 (1954).

A review article outlining the principal characteristics of radiation damage, and discussing in particular the results of experiments on germanium and copper and the conclusions to be drawn from them.

A. D. LE CLAIRE

548.7 : 539.185

10638. Neutron irradiation on indium antimonide. J. W. Cleland and J. H. Crawford, Jr. *Phys. Rev.*, **95**, 1177–82 (*Sept.* 1, 1954).

Hall coefficient and resistivity measurements as a function of temperature have been made on both *n*- and *p*-type single crystalline samples of InSb after successive periods of exposure in the Oak Ridge Graphite reactor. Effects due to the introduction of Sn, a donor impurity, were minimized by shielding the specimens from those neutrons leading to In transmutation with cadmium and indium foil. The results of these measurements indicate conclusively that lattice defects produced by fast-neutron bombardment convert *p*-type InSb to *n*-type. In addition they appear to act as shallow electron traps in *n*-type material. The mobility of carriers is markedly decreased by the bombardment-produced defects, but this decrease in mobility, as well as changes in carrier concentration resulting from bombardment-produced energy states can be essentially completely removed by appropriate heat treatment. An attempt has been made to correlate the various possible simple defects expected in the InSb structure with the nature of energy levels introduced by fast-neutron bombardment. A.

548.7 : 539.373

10639. A theory of the formation of slip bands in face-centred cubic crystals. H. Suzuki. *J. Phys. Soc. Japan*, **9**, 531–40 (*July–Aug.*, 1954).

A theory of slip band formation in a face-centred cubic crystal was given introducing three concepts: a Frank–Read source multiplying dislocations in successive atomic planes; the co-operative action of Frank–Read sources; and the different distribution of dislocations in the vicinity of the free surface from that in the interior of the crystal. By means of the former two, about one thousand dislocations could be multiplied from each source under the critical shear stress of the source without any dynamical effects. The third enables the difference in surface structures between abraded and unabraded crystals to be illustrated. A.

548.7

10640. Wave functions for impurity levels. G. F. Koster and J. C. Slater. *Phys. Rev.*, **95**, 1167–76 (*Sept.* 1, 1954).

The calculation of impurity levels in crystals is set up in terms of a linear combination of Wannier functions. The coefficients of this linear combination are shown to satisfy a set of difference equations, which are solved for two simple linear chain impurity problems. The difficulties encountered in solving the difference equations are explored on the basis of these examples and a general method of solving difference equations arising from impurity calculations is presented. This method seems to have advantages over previous methods of solving the impurity problem in crystals. A.

548.7

10641. The colour centre yield in rocksalt for medium energy β-rays. O. Drexler. *S.B. Österr. Akad. Wiss. IIa*, **162**, *No.* 5–7, 253–68 (1953) *In German.*

Crystals are coloured with monochromatic β-rays from a Ra (B and C) source and spectrometer. The *F*-centre yield for 130–450 keV β-rays is proportional to the β-energy and is from 20 to 70 *F*-centres per β-particle with a formation energy of $\sim 6{\cdot}4$ keV/*F*-centre. *F*-centre concentrations of the order of $10^{17}/cm^3$ are reached for these measurements.

G. F. J. Garlick

548.7

10642. On the *F*-coloration of fluorite. K. Przibram. *S.B. Österr. Akad. Wiss. IIa*, **162**, *No.* 5–7, 269–84 (1953) *In German.*

548.7

10643. On the coloration of NaCl, KCl and CaF_2 by cathode rays. K. Treitl. *S.B. Österr. Akad. Wiss. IIa*, **162**, *No.* 8–10, 423–34 (1953) *In German.*

Excitation of NaCl and KCl by 10 keV electrons gives saturation *F*-centre concentrations of $5\times10^{19}/cm^3$ and $2{\cdot}9\times10^{19}/cm^3$ respectively but no saturation is reached in CaF_2. Heat treatment of NaCl produces very little effect on rate of coloration or absorption characteristics. Splitting of the KCl *F* band for high *F*-centre concentrations occurs only slightly. The absorption spectra of CaF_2 for X-ray and electron bombardment are not identical and show different stabilities under thermal treatment. G. F. J. Garlick

548.7

10644. Optical excitation of the binary colour centre in ionic crystals. M. F. Deĭgen. *Zh. éksper. teor. Fiz.*, **24**, *No.* 6, 631–42 (1953) *In Russian.*

Calculations are carried out for the self-consistent excited quantum state of a binary colour centre F_2 (a system consisting of two interacting colour centres) in ionic crystals, in order to determine the parameters of this state, the energy of thermal dissociation of the excited F_2-centre and the frequency of the maximum in the absorption band due to F_2. Results of the theory proposed are applied numerically to KCl and KBr crystals; the calculated maxima of the F_2 absorption bands agree fairly well with experimental data (for the *R* bands). F. Lachman

548.7

10645. Multiple centres and their role in secondary phenomena in alkali halide crystals. N. P. Kalabukhov. *Zh. éksper. teor. Fiz.*, **26**, *No.* 2, 242–7 (1954) *In Russian.*

Absorption spectra of additively and X-ray coloured crystals of KCl are considered. It is pointed out that *R* and *R'* bands at 730 mμ and 675 mμ appear in the first in the dark and in the second only after illumination in *F'* band light. Centres are considered as being derived from quartets of halogen and K^+ vacancies. The latter get filled up by K^+ and the former by one (*R'*) or by two electrons (*R*). Excitation spectra of dark current agrees approximately with absorption spectra in *R* and *R'* bands and dark current only appears in X-rayed crystals after illumination in *F'* band. It is therefore considered that dark current is associated with *R* and *R'* centres. The energies of dissociation derived from conductivity–temperature relations are only 0·31 and 0·46 eV as compared with optical excitation energies 1·61 and 1·81, but this difference between optical and thermal excitation of electrons is known to exist in other centres. J. Ewles

548.7

10646. Polarized excitons in crystals of KCl type. I. M. Dykman. *Zh. éksper. teor. Fiz.*, **26**, *No.* 3, 307–16 (1954) *In Russian.*

The model proposed consists of positive charge $+e$ at halide site with $-\frac{1}{6}e$ at six neighbouring metal sites. The displacement and polarization of the ions, giving the polarity of the multipole, is determined. With KCl as an example, the position, half-width and temperature dependence of the band associated with this exciton is calculated. There is satisfactory agreement with the experimental band at 1620 Å. J. EWLES

548.7

10647. Coloration and colour centres in calcium fluoride crystals. A. Smakula. *Z. Phys.*, **138**, *No.* 3–4, 276–83 (1954) *In German.*

Synthetic CaF_2 crystals of various qualities (determined by ultraviolet transmission, density, ionic conductivity and spectrographic analysis) were coloured by 2·5 MeV electrons, Ca vapour or electron diffusion. Band maxima occur at 2·16, 3·14, 3·7 and 5·5 eV, the band intensity ratios remaining constant up to the highest colorations ($k = 3$ mm^{-1}). Crystals with smaller densities, high conductivity and poor ultraviolet transmission can be more strongly coloured than pure crystals, and their absorption bands vary markedly in intensity and position. It is concluded that the bands are due to lattice defects and not to foreign impurities. G. F. J. GARLICK

548.7

10648. V_1 and H centers in KCl. K. Teegarden and R. Maurer. *Z. Phys.*, **138**, *No.* 3–4, 284–9 (1954).

Optical bleaching of V_1- or H-centres in KCl yields no free charge in contrast to thermal bleaching. Using the Seitz model of H-centres the formation of the latter by V_1-band bleaching at 35°K is due to tunnelling of some of the holes from V_1-centres to neighbouring vacancy pairs. G. F. J. GARLICK

548.7

10649. Shape of the F band. R. V. Hesketh and E. E. Schneider. Letter in *Phys. Rev.*, **95**, 837–8 (*Aug.* 1, 1954).

Experimental measurements of the F band in KCl crystals coloured by X-rays ($10^{16} - 10^{17}$ F-centres/cm^3) at 290°K and 113°K show that its shape is approximately Gaussian whereas in additively coloured crystals it has a Lorentzian form. G. F. J. GARLICK

548.7

10650. Color centers in alkali silicate and borate glasses. R. Yokota. *Phys. Rev.*, **95**, 1145–8 (*Sept.* 1, 1954).

The colour centres induced by X-ray irradiation in the alkali silicate and borate glasses and the mixed alkali glasses are studied. By preparing samples of various compositions in the reducing and in the oxidizing condition, and by optical and thermal bleaching it is concluded that the visible band is due to electrons trapped by oxygen vacancies neighbouring alkali ions and that the ultraviolet band is due to positive holes trapped by alkali ion vacancies neighbouring oxygen ions. A.

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See Abstr.* 10560–7

548.73

10651. Theory of the diffuse reflection of X-rays by crystals. I. J. Laval. *J. Phys. Radium*, **15**, 545–58 (*July–Aug.–Sept.*, 1954) *In French.*

The theories of Waller and of Born [M. Born, *Rep. Progr. Phys.*, **9**, 294–333 (1942–3)] are examined, with special reference to the modes of quantization of the elastic waves in the crystal. These two theories do not give precisely the same result for the X-ray scattering. A matrix theory of diffuse scattering is then developed, which takes exact account of the quantization of the elastic waves: the scattering is considered as the result of selective reflection by the waves of electron density formed by the elastic waves, account being taken of the change of frequency of the reflected radiation due to interchange of energy between the incident photons and the vibrating lattice. A. R. STOKES

548.732

10652. Transmission of X-rays through calcite in Laue diffraction. G. Schwarz and G. L. Rogosa. *Phys. Rev.*, **95**, 950–3 (*Aug.* 15, 1954).

Precise measurements of the shape of the transmitted intensity curve in the case of Laue diffraction in high quality calcite have been made at a wavelength of 0·708 Å. The range of crystal thicknesses investigated, from 0·05 to 0·620 cm, clearly shows the transition from extinction to anomalous transmission. Values of the crystal absorption coefficient at the diffracting position are given. For the thick crystal case, for example, the absorption coefficient at anomalous transmission for a 0·563 cm crystal was 6·61 cm^{-1} compared with a normal absorption coefficient value of 22·0 cm^{-1}. Comparison of the data with theoretical results of Hirsch, Ramachandran and Kartha, and Zachariasen shows reasonable agreement. A.

548.732.2

10653. On the anomalous absorption of X-rays by crystals at the setting of Bragg reflection. H. Yoshioka. *J. Phys. Soc. Japan*, **9**, 636–40 (*July–Aug.*, 1954).

Intensities of X-rays transmitted through crystals of calcite, topaz and pyrite at the settings of Bragg reflections were studied using a double-crystal spectrometer. In the case of Mo$K\alpha$, transmission patterns have minima at Bragg angles. However, an asymmetry is noted in the patterns. In the case of Cu$K\alpha$, the transmission pattern through calcite has a large maximum near the Bragg angle accompanying a small minimum on the side of large glancing angles. A.

548.733

10654. Construction of a powder camera on Brentano's principle. A. J. Rose and C. Rérat. *Bull. Soc. Franç. Minéral. Crist.*, **77**, 748–58 (*April–June*, 1954) *In French.*

A flat specimen and a fairly divergent X-ray beam are used. As the specimen is rotated, a window moves so as to pass only the diffracted beam which is focused on the film at a given time. The construction

is described, and the magnitude of the instrumental line broadening is considered. A. R. STOKES

548.733

10655. A high-temperature X-ray back-reflection camera for single crystals. J. TELTOW. *Z. angew. Phys.*, **6**, 280–2 (*June*, 1954) *In German.*

The camera is designed for precise lattice-parameter measurements in the temperature range 20°–450°C. It employs Seemann–Bohlin focusing, and the exposure time is much smaller for a single crystal than for a powder specimen. A. R. STOKES

548.733

10656. X-ray diffraction camera for back-reflection examination under variable incidence. R. BERNARD AND R. RIVIÈRE. Letter in *J. Phys. Radium*, **15**, 495–6 (*June*, 1954) *In French.*

Describes the construction of a Seeman–Bohlin type camera for use on large solid specimens.

A. R. STOKES

548.733

10657. Automatic pole figure recorder. A. H. GEISLER. *Rev. sci. Instrum.*, **25**, 727–32 (*Aug.*, 1954).

A device has been developed for the direct recording in stereographic projections of pole-figure data as they are supplied from a Geiger-counter X-ray diffraction apparatus. The specimen is rotated systematically in a suitable goniometer about two axes in synchronism with movements of the chart and printer on the recorder. When the diffracted intensity attains any one of seven preset levels, the printer impresses a point of corresponding colour on the chart. The point is printed at the location that has the stereographic co-ordinates of the pole of the diffracting volume. After all possible orientations of the specimen have been explored, an array of coloured points will have been obtained on the chart. When contour lines are sketched through points of like colour, the usual pole figure with iso-intensity lines is obtained. A.

548.733

10658. A Geiger counter X-ray crystal spectrometer. P. J. A. MCKEOWN AND A. R. UBBELOHDE. *J. sci. Instrum.*, **31**, 321–6 (*Sept.*, 1954).

The design and construction of a spectrometer suitable for the study of transitions in single crystals is described. Details are given of the stabilized X-ray source and intensity measuring circuits. The instrument is suitable for rapid measurements of Bragg angles and intensities of X-ray reflections, and for following crystal imperfections whilst the crystal is undergoing thermal or other treatment. A.

548.734

10659. A construction giving the projection of the point *h*00 on the 0*kl* plane in reciprocal space, for non-orthogonal axes. E. W. RADOSLOVICH. Note in *Acta cryst.*, **7**, 513 (*July* 20, 1954).

A simple geometrical construction, and its proof, are given. A. R. STOKES

548.734

10660. A method for setting the equi-inclination angle. D. SAYRE. Note in *Acta cryst.*, **7**, 516 (*July* 20, 1954).

The angle of mis-set (in a Weissenberg photograph) is rapidly obtained from a trial photograph. The method applies to crystals of monoclinic or higher symmetry. A. R. STOKES

548.735

10661. The maximum probable value of the reliability index for a hypercentric structure. A. S. DOUGLAS AND M. M. WOOLFSON. Note in *Acta cryst.*, **7**, 517 (*July* 20, 1954).

For a centrosymmetric arrangement of centrosymmetric units, it is shown that the max. probable value of the reliability index for an incorrect structure is 1·010. A. R. STOKES

548.735.44

10662. On the termination effects in the Fourier analysis of a crystal. K. DOI. *Proc. Japan Acad.*, **30**, 180–2 (*March*, 1954).

It is shown that one can readily pick out the spurious peaks in a terminated Fourier synthesis of electron density, because they must lie on the maxima of diffraction patterns surrounding the true peaks.

A. R. STOKES

548.736

10663. The metamict state. W. PRIMAK. Letter in *Phys. Rev.*, **95**, 837 (*Aug.* 1, 1954).

Lists of substances are given which, after neutron irradiation, showed either no change in X-ray powder pattern, changes in lattice parameter, or line broadening. A. R. STOKES

548.736.3 : 536.413

Lattice expansion of KCl between 20 and 600°C. *See Abstr.* 10126

548.736.3 : 537.312.62

10664. The structure of superconductors. IV. X-ray and metallographic examination of the system Bi–Pd. N. N. ZHURAVLEV AND G. S. ZHDANOV. *Zh. éksper. teor. Fiz.*, **25**, *No.* 4 (10) 485–90 (1953) *In Russian.*

A high-temperature (β) modification of Bi_2Pd was found which was tetragonal, with space group I4/mmm and cell dimensions $a = 3{\cdot}362 \pm 0{\cdot}001$ and $c = 12{\cdot}983 \pm 0{\cdot}001$ Å. $Z = 2$ and $\rho_{obs.} = 11{\cdot}7$ g/cm³. Two Pd atoms lie in (*a*) positions and 4 Bi in (*e*) positions with $z = 0{\cdot}363$. A low-temperature (α) modification with the same formula was monoclinic, crystals being elongated parallel to *b*. The cell dimensions were $a = 12{\cdot}6$, $b = 4{\cdot}0$ and $c = 5{\cdot}8$ (all $\pm 0{\cdot}2$) Å with $\beta = 102° \pm 1°$, $\rho_{obs.} = 12{\cdot}5$ g/cm³ and $Z = 4$. BiPd crystals were orthorhombic with cell dimensions $a = 10{\cdot}8$, $b = 8{\cdot}6$ and $C = 7{\cdot}2$ (all $\pm 0{\cdot}2$) Å, $\rho_{obs.} = 12{\cdot}5$ g/cm³ and $Z = 16$. Up to 28% Bi can be taken into Pd as a solid solution with a maximum increase in linear cell dimensions of 3%. An aqueous solution of KI and iodine was used for etching specimens. [For Pts I–III, see later.]

A. L. MACKAY

548.736.3 : 541.124

10665. Formation, stability and crystal structure of solid silicon monoxide. M. HOCH AND H. L. JOHNSTON. *J. Amer. Chem. Soc.*, **75**, 5224–5 (*Nov.* 5, 1953).

The formation of solid silicon monoxide from a mixture of silicon and silicon dioxide according to the reaction $Si + SiO_2 \rightarrow 2SiO$ was observed from

X-ray diffraction patterns taken at 1250 and 1300°, during various time intervals. The crystal structure and lattice constants of Si and SiO were determined at 1300 and 25°. Results showed that Si has the same body-centred lattice at 1300° as at room temperature, with a lattice constant of $a = 5{\cdot}445$ Å at 1300° and $a = 5{\cdot}413$ Å at 25°. The lattice of SiO was found to be cubic, the lattice constants at 1300 and 25° being 7·135 and 7·09 Å, respectively. A.

548.737

10666. X-ray diffraction by naphthalene in the liquid state and in the solid state. II. F. CENNAMO. *Nuovo Cimento*, **12**, 165–73 (*Aug.*, 1954) *In Italian.*

For Pt I, see Abstr. 1266 (1953). The intensity distributions of X-rays diffracted by naphthalene in powder and in liquid form are compared. The change from the liquid to the solid state apparently occurs with little change of the microstructure. An attempt is made to establish the dimensions of the molecular clusters existing in the liquid. A.

548.737

10667. The structure of haemoglobin. III. Direct determination of the molecular transform. M. F. PERUTZ. *Proc. Roy. Soc. A*, **225**, 264–86 (*Aug.* 31, 1954).

For Pt II, see Abstr. 4030 (1954). Horse methaemoglobin crystallizes with two molecules in a face-centred monoclinic unit cell (space group $C2$), in which rigid layers of molecules parallel to (001) alternate with layers of liquid. The crystals can be made to swell and shrink in a series of steps involving changes in $d(001)$ and in the angle β. It appears that only the distances between the molecular layers change, but not their internal structure. The lattice changes allow the modulus of the molecular Fourier transform to be sampled along lines of constant h and k. When $k = 0$ the transform is real and the sampled values of $|F|$ describe a series of loops and nodes. Pt I of this series dealt with the principles of deciphering these and established the absolute signs of the $00l$ reflections. In Pt II the absolute signs of certain $20l$ reflections were derived from the changes in intensity produced by the substitution of salt solution for water as the liquid of crystallization. In this paper the transform is measured for all values of h and l up to $\lambda/d = 0{\cdot}24$, comprising nine layer lines in all. The absolute signs of layer lines with $h > 2$ are left in doubt, but many sign relations are established within each of them. It is difficult to assess exactly the number of sign relations found by the transform method, but it is estimated that the number of alternative sign combinations is reduced from 2^{96} to 2^{13}. The remaining uncertainties are cleared up by the isomorphous replacement method described in Pt IV. A.

548.737

10668. The structure of haemoglobin. IV. Sign determination by the isomorphous replacement method. D. W. GREEN, V. M. INGRAM AND M. F. PERUTZ. *Proc. Roy. Soc. A*, **225**, 287–307 (*Sept.* 14, 1954).

Native horse haemoglobin contains free sulphydryl groups and forms crystalline compounds with *para*-mercuribenzoate groups and with silver ions. Crystals in which two of the four available SH groups are so combined are exactly isomorphous with normal monoclinic methaemoglobin, but exhibit significant changes in the intensities of many reflections. The changes in $F(h0l)$ were used to determine the x and z parameters of the pair of heavy atoms attached to each haemoglobin molecule; this was done both for the normal wet lattice and for one of the acid-expanded lattices. The positions of the heavy atoms proved to be slightly different in each case, giving rise to three sets of diffraction fringes, each set making measurable contributions in different areas of the reciprocal net. In each case the isomorphous substitution allowed the signs of just over two-thirds of the reflections to be found with certainty. Between them the three sets of diffraction fringes determined the signs over the entire area of the $h0l$ plane so far investigated. These signs were then superimposed on the waves of the transform described in previous papers of this series. All the sign relations established by the transform method were confirmed and the remaining uncertainties cleared up. Comparison of the transform with the three sets of isomorphous replacement results allowed the consistency of the signs to be rigorously checked; not a single inconsistent sign was found. In the normal wet lattice the mercury and the silver compounds between them allowed the signs of 87 out of 94 reflections to be found with certainty. This suggests that the isomorphous replacement method may offer a way of finding the phases in protein crystals even when practical difficulties preclude the use of the transform method. A.

548.737

10669. The structure of haemoglobin. V. Imidazole–methaemoglobin: a further check of the signs. E. R. HOWELLS AND M. F. PERUTZ. *Proc. Roy. Soc. A*, **225**, 308–14 (*Sept.* 14, 1954).

The crystals are apparently orthorhombic; their unit-cell dimensions and the intensities of the $00l$ reflections suggest a structure closely related to monoclinic methaemoglobin. Each structure appears to contain the same molecular layers parallel to (001), but in the monoclinic form the molecules are tilted the same way in each layer, while in the new form the tilt is alternately left and right in successive layers. Precession pictures show an interesting sequence of sharp and diffuse layer lines, those with certain indices h containing streaks parallel to c^*. In other layer lines the spots are broadened in varying degrees. The amplitudes of the $h0l$ reflections are related to the molecular Fourier transform described in previous papers of this series. Each value of $F(h0l)$ is compounded from the sum or the difference of the amplitude at two points on the transform having the co-ordinates $ha^*\ 0\ lc^*$ and $ha^*\ 0\ \bar{l}c^*$. The rules for addition and subtraction of amplitudes follow a simple scheme which is related to the sequence of sharp and diffuse layers. The scheme accounts for all observed values of $F(h0l)$, a reliability factor of 0·21 being obtained. This correlation provides an independent check for the sequence of signs along certain layer lines of the transform. A preliminary analysis of the structure is made, and molecules in neighbouring layers are shown to be displaced by 11·2 Å in the a direction. A.

548.737

10670. The structure of haemoglobin. VI. Fourier projections on the 010 plane. L. Bragg and M. F. Perutz. *Proc. Roy. Soc. A*, **225**, 315–29 (*Sept.* 14, 1954).

In the preceding papers the molecular Fourier transform was measured as a continuous function of c^* along nine lines of constant h in the plane of $k = 0$. Fourier inversion of this transform gives an electron density map of a single row of molecules in projection on the 010 plane. This map shows molecules of irregular outline and complex internal structure. Because of lack of resolution and the great depth of material projected neither polypeptide chains nor haem groups can as yet be recognized. Along the c^* direction the molecular dimensions can be measured with accuracy; along the a direction this is not yet possible, owing to overlap of neighbouring molecules in projection. Indications of the length of the molecules in that direction are obtained from the Fourier projection of a lattice slightly shrunk along a. At low resolution the molecular dimensions can be estimated from a Fourier projection derived by inversion of the "salt-water" transform described in Pt III, which corresponds to the diffraction by a row of "ghost" molecules having the same shape as haemoglobin, but a uniform density throughout. The tilted spheroid of 71×54 Å proposed in Pt II, is a good approximation to the outline of the molecule shown on this projection. Its only unexpected feature is a hollow at the central dyad where the thickness of the molecule is apparently reduced to 32 Å. It is not yet clear what this hollow represents. A.

548.74

10671. A study of anomalous refraction effect in electron diffraction. II. Zinc-oxide smoke. S. Kuwabara. *J. Sci. Hiroshima Univ. A*, **17**, 221–8 (*Dec.*, 1953).

For Pt I, see Abstr. 7042 (1954). The Debye–Scherrer rings for ZnO smoke show reflections from single crystallites split into symmetrical groups of spots. This fine structure is quantitatively treated by the method of Honjo [Abstr. 6578 (1949)].

R. REED

548.74

10672. Lattice constants of Te, HgTe and HgSe. U. Zorll. *Z. Phys.*, **138**, *No.* 2, 167–9 (1954) *In German.*

The lattice constants, measured by electron diffraction, using LiF as a reference substance, are: Te, $a = 4{\cdot}45_5$, $c = 5{\cdot}88_0$; HgTe, $a = 6{\cdot}429$ and HgSe, $a = 6{\cdot}074$ Å. J. THEWLIS

548.74

10673. Electron diffraction study on the ordered alloy CuAu. S. Ogawa and D. Watanabe. *J. Phys. Soc. Japan*, **9**, 475–88 (*July–Aug.*, 1954).

The ordered state in the gold–copper alloy of atomic ratio 1 to 1 was investigated by electron diffraction with well orientated thin films. Below 340°C the pattern corresponded with a tetragonal superlattice the c axis of which is distributed into three original cubic axes, while above 360°C sharp crosses appeared at some of the positions of superlattice reflection, being accompanied with subsidiary maxima, and at the same time regularly spaced satellites arose around normal reflections, especially around the incident beam position. The former phenomenon could be clearly interpreted by antiphase domains which occur in the tetragonal superlattice and which lead to the orthorhombic CuAu II structure, and the latter, which was first found by this experiment, proved that a definite expansion of lattice appears periodically in each boundary of antiphase domains, due to the asymmetrical distribution of gold and copper atoms at this place and to the tetragonality. Among the satellites around normal spots, only those around the direct spot are thought to be fundamental and those around the other normal spots arise from the secondary elastic scattering peculiar to electron diffraction and are the mere repetitions of the fundamental satellites. Thus, the lattice of CuAu II possesses an inherent defect which has hitherto been overlooked. The transitional region between CuAu II and the cubic phase in the equilibrium diagram was also studied, the composition of films being varied in the vicinity of 1 to 1, and it was concluded that the two phases surely coexist as in the case of CoPt. A.

548.74 : 518.5

10674. Mechanical analog computer for reading electron diffraction patterns. W. R. McMillan. *Rev. sci. Instrum.*, **25**, 545–7 (*June*, 1954).

An instrument, employing the principle of a slide multiplier, has been constructed for reading electron diffraction patterns and computing the corresponding crystal lattice spacings. The constant of the electron diffraction camera can have a value of from zero to 5000 Å cm, and the instrument can record "d_{hkl}" spacings from 0·600 to 7·000 Å. These spacings are printed, together with estimated line intensities, on adding machine paper. The instrument decreases the possibility of accidental error in copying numbers, and also eliminates considerable fatigue when many patterns have to be read. A.

548.74 : 539.185

10675. New goniometers for single-crystal neutron diffraction studies. R. Pepinsky, B. C. Frazer and M. L. McKeown. *Rev. sci. Instrum.*, **25**, 699–703 (*July*, 1954).

A new type of goniometer has been designed and constructed for neutron diffraction analyses, and particularly for single-crystal studies. The neutron detecting system employs a scintillation crystal and photo-multiplier, or a miniature high-pressure BF_3 counter; and the detector and diffracting crystal are located within a cylindrical shielded region, in such a manner that the moving parts are entirely free of heavy shielding elements. When a miniaturized BF_3 counter is used, no shielding except B_4C in plastic immediately surrounding the counter is required. Rotations are accomplished by servo-controlled motors, with selsyn indicators coupled to an external servo system. This servo control is designed to permit future introduction of automatic crystal and detector setting. The system is small and inexpensive, and has the particular advantage of readily permitting three-dimensional diffraction measurements. A.

GEOPHYSICS 55

550.93

10676. Geochronological significance of extinct natural radioactivity. T. P. KOHMAN. *Science*, **119**, 851–2 (*June* 11, 1954).

Report on a programme of work supported by the U.S. Atomic Energy Commission, involving a statistical examination of β-labile nuclides near stability (J. W. Jones, R. A. Brightsen and P. T. Kohman, 1954), which suggests that there may well be a few having half-lives (within the order of a factor of about 3) of 10^8 years. This would be in keeping with the requirement of a minimum half-life of about 3×10^7 years for traces of the decay product to be detected unambiguously at the present time, and thus lead to a determination of relative times for geologic events in widely separated parts of the earth and, through the fixation of one time-point, to absolute ages. It is stated that in order to be useful for geochronometry, such a nuclide and its daughter must each have a stable or long-lived isotope and must, furthermore, belong to elements that are geochemically fractionated to an appreciable extent. An experimental search for extinct natural radionuclides, in progress in the authors' laboratories at the Carnegie Institute of Technology at Pittsburgh, Penn., involves artificial production of nuclides suspected of being long-lived, and isolation from selected minerals and meteorites of the hypothetical daughter elements for mass-spectroscopic analysis.

A. BEER

ATMOSPHERE . METEOROLOGY 551.5

551.508 : 551.574

10677. A three thousand cubic meter cloud chamber. R. GUNN AND P. A. ALLEE. *Bull. Amer. Meteorol. Soc.*, **35**, 180–1 (*April*, 1954).

Details are given of a 60 ft spherical cloud chamber of 1 in. steel plate which operates to a pressure of 4 atm. and can be rendered free from dust, air and water leakage, and electrical interference. Experiments are conducted near the centre where the walls cause no modification. Instruments and observer can be raised on a platform through a manhole at the base to the centre. Adiabatic lowering of cloud temperature by as much as 50°C allows the production of warm, supercooled, or ice crystal clouds as desired. A small underground laboratory immediately below the cloud chamber allows evaluation of the behaviour of the clouds and droplets during descent, with more than an hour for observation. The cloud chamber permits control over a practical range of temperature, free water, the speed of expansion, the number and character of nuclei, the ionization of the ambient air and the droplet size distribution in any cloud, and thus a great amount of basic information is obtained.

R. S. READ

551.508.19 : 621.317.79

10678. Rocket instrumentation for reliable upper-atmosphere temperature determination. N. W. SPENCER, H. F. SCHULTE AND H. S. SICINSKI. *Proc. Inst. Radio Engrs*, **42**, 1104–8 (*July*, 1954).

A description of equipment whereby temperature is determined basically by pressure difference along the nose cone. The equipment consists of ~5 alphatron units feeding through a commutator and limiter to the rocket transmitter plus a gyroscope and 16 mm camera. Each alphatron unit is made up of a Ra ionization gauge, located at some point on the cone surface, which feeds into a d.c. amplifier with unity feedback. To utilize the working range of the gauge to the full and yet remain within the 0·5–5·0 V input range of the telemeter, the whole range is divided into 8 sub-ranges, changeover from one sub-range to the next being effected automatically as required by switching the resistance load of the gauge. The commutator selects each in turn of 20–40 different signals to pass through the protecting limiter to the 493 Mc/s transmitter. The gyro determines the heading of the rocket in relation to its axis and presents the information to the camera. Three ground stations record data sent out by the telemeter when interrogated by a 470 Mc/s ground transmitter. Accuracy of ultimate temp. determination is ~2%.

H. G. M. SPRATT

551.508.71

10679. Some experiments on the speed of response of the electrolytic hygrometer. V. B. MORRIS, JR AND F. SOBEL. *Bull. Amer. Meteorol. Soc.*, **35**, 226–9 (*May*, 1954).

A simplified theory of the speed of response of electrolytic humidity sensing elements is proposed and experimental measurements which support the theory are presented. Some methods are suggested for obtaining maximum speed of response with sorption hygrometers.

A.

551.508.79

10680. Radar echoes from monsoon rain. L. S. MATHUR, A. C. DE, B. N. DUTTA AND H. MITRA. *Indian J. Meteorol. Geophys.*, **5**, 173–86 (*April*, 1954).

Describes an air-borne radar set, modified for storm-detection work from a static station. A few typical pictures of radar echoes from monsoon rain as observed from the Meteorological Station at New Delhi are described. The usefulness of the equipment for precipitation studies is discussed.

A.

551.510.535

10681. Procedures used to improve the quality of ionospheric data. S. C. GLADDEN. *Trans Amer. Geophys. Un.*, **35**, 398–404 (*June*, 1954).

Outlines procedures used in the examination of data received from 21 field stations. Figures are provided to illustrate the type of records examined and the results of interstation comparison. Stations separated by not more than four degrees of geomagnetic latitude are compared graphically as regards monthly medians of the various characteristics. Discoveries of operating errors which had escaped observation for several months are described. A type of scaling error discovered by graphical comparison of stations is mentioned.

A.

551.510.535

10682. *F*-scatter at Huancayo, Peru, and relation to radio star scintillations. H. W. WELLS. *J. geophys. Res.*, **59**, 273–7 (*June*, 1954).

The scattering of radio waves by the *F*-region of the ionosphere at an equatorial location (Huancayo, Peru) was discussed by Booker and Wells (1938). Subsequent analysis reveals pronouncedly diurnal, seasonal and annual characteristics. It is fundamentally a night-time event, with greatest frequency of occurrence in the period from four hours before midnight to four hours after midnight. The scattering is most prevalent during seasons when the sun is overhead and is infrequently observed during May, June, July and August (local winter) when the noon solar zenith angle becomes as great as 35°. The relative total annual occurrence of *F*-region scatter for the period 1938 through 1945 shows low values during 1941–1942, followed by a rapid increase through 1946, which is not closely related to solar activity. The diurnal properties of *F*-scatter closely correspond to reported characteristics of radio star scintillations with peak activity around midnight. However, the annual or seasonal properties are not in simple agreement. A.

551.510.535 : 523.75

10683. The enhancement of ionospheric ionization during solar flares. A. P. MITRA AND R. E. JONES. Note in *J. atmos. terrest. Phys.*, **5**, 104–6 (*May*, 1954).

Two hypotheses have been put forward to explain this phenomenon, (i) an increase in electron production, (ii) an increase in the negative ion to electron concentration. Recent work by Mitra and Jones on the recombination coefficient in the lower ionosphere does not support the second hypothesis. In this paper it is concluded that the first is the correct explanation.

J. M. HOUGH

551.510.535 : 621.396.11

10684. Some aspects of the rapid directional fluctuations of short radio waves reflected at the ionosphere. E. N. BRAMLEY. *Instn Elect. Engrs Paper* 1713, 8 *pp.* [To be published also in *Proc. Instn Elect. Engrs.*]

Measurements have been made of the rapid directional fluctuations observed on single-component first-order ionospheric echoes, at vertical and oblique incidence (range 700 km), and on frequencies of 2·5–10·5 Mc/s. Under quiet ionospheric conditions the r.m.s. angular deviations are of the order of 1° or less, but they are appreciably greater under ionospheric-storm or spread-*F* conditions. The fluctuations are uncorrelated at an interval of 5 sec. It is shown that a layer of irregular ionization-density within region *E* would account for the quiet-condition *F*-layer results, and this would require random variations of the phase path through the region of the order of only 3 m at a frequency of 5 Mc/s. The *E*-layer results appear to be affected by partial reflections at different levels within the region. A.

551.510.535 : 621.396.11 : 621.376.33

10685. An apparatus for the detection of weak ionospheric echoes. S. GNANALINGAM. *Proc. Instn Elect. Engrs III*, **101**, 243–8 (*July*, 1954).

An apparatus is described with which weak ionospheric echoes can be detected and their heights measured; it makes use of f.m. and coherent integration. With a transmitted power of 250 W and an output bandwidth of 1 c/s the apparatus makes possible the detection of echoes corresponding to a reflection coefficient of 3×10^{-5} (attenuation of 10 nepers). The principle may be of use in the design of sensitive radar equipment. A.

551.593.9 : 535.338.3

10686. Critical remarks on the height-determination of the sodium twilight-glow. G. CARIO AND U. STILLE. *Z. Phys.*, **138**, *No.* 3–4, 372–80 (1954) *In German.*

Resonance emission of the *D*-lines from neutral Na atoms must be limited to an altitude not exceeding ~85 km since above this height these atoms will be ionized by u.v. radiation. The conventional zenith-horizon method of height mesurement yields values some 50% greater. It is here pointed out that the observed intensity ratio, I_{hor}/I_{zen}, will be very dependent on the amount of additional absorption at the lower altitude due to dust particles in the lowest atmospheric layers. When proper corrections are applied the observed height will be reduced (in an example cited, by 20 km). The significance of the corrected height estimates is discussed in relation to the probable vertical distribution of atmospheric Na atoms. D. R. BARBER

551.593.9 : 535.338.4

10687. The occurrence of ionised nitrogen bands in the twilight spectrum. M. COSTELLO, H. SERSON, R. MONTALBETTI AND W. PETRIE. Letter in *Canad. J. Phys.*, **32**, 562 (*Aug.*, 1954).

Spectra of twilight in the region of the (O, O)N_2^+ band at 3914 Å, photographed from stations in N.W. Canada during July–October, 1953, and March–April, 1954, have been examined along with local magnetic records in order to establish the extent to which N_2^+ ions contribute to the normal *E*-layer ionization. They show that the 3914 Å band does not appear unless a geomagnetic disturbance is in course. Thus there are either very few N_2^+ ions normally present in the ionosphere, or these ions are removed so rapidly that the number of quanta radiated at 3914 Å is inappreciable. D. R. BARBER

551.594.14

10688. On the natural radioactivity of rainfall. P. E. DAMON AND P. K. KURODA. *Trans Amer. Geophys. Un.*, **35**, 208–16 (*April*, 1954).

In the measurements reported the radioactivity varied from 1 to 60 mμ curies per litre of rain water and was due primarily to RaB + C. The activities due to ThB and RaD were less than 10^{-10} and 10^{-11} curie per litre each, respectively. RaA is present in rain water at the time it reaches the earth's surface. The mechanism for the accumulation of decay products in rain water is discussed. The total activity (per unit area and time) increases toward the limiting value determined by the supply of RaA from Rn. An average atmospheric Rn concentration within the cloud system of approximately $0\cdot2\times10^{-13}$ curie per litre is sufficient to supply the rain water with the observed radioactivity. The natural radioactivity of the atmosphere can be used as a tracer to study meteorological phenomena. A.

551.594.5 : 538.566.2

A note on auroral interaction. *See Abstr.* 10359

BIOLOGY 57/59

578.087.86 : 536.532

10689. Improved needle thermocouple for subcutaneous and intramuscular temperature measurements in animals and man. J. KROG. *Rev. sci. Instrum.*, **25**, 799–800 (*Aug.*, 1954).

A method is described for the construction of thermocouples inside of a No. 25 hypodermic needle yet still strong enough to withstand hard use in the field. Utilization of the couples in subcutaneous temperature measurements in man and animals outdoors for approximately three years has demonstrated satisfactory operation under weather conditions varying from rain to arctic temperatures of −50°c. A.

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.1 : 539.16

10690. Note on the interpretation of tracer experiments in biological systems. H. D. LANDAHL. *Bull. math. Biophys.*, **16**, 151–4 (*June*, 1954).

It is shown that the results of Sheppard and Householder [Abstr. 4958 (1951)] can be modified to include open systems which may or may not be in the steady state. Some conditions are given under which simple chemical reactions can be included. A.

612.843.611

10691. On the mechanism of the visual threshold and visual adaptation. G. WALD. *Science*, **119**, 887–92 (*June* 25, 1954).

This paper contains an attempt to explain the phenomena of dark-adaptation and absolute thresholds on a new photo-chemical basis which invokes the structure of the rod, as revealed by electron-microscopic studies. An original experiment in which light of different intensities is focused by an artificial eye on a solution of cattle visual purple, and an observer's dark-adaptation curve is measured under similar lighting conditions, leads to comparable estimates of the number of bleached molecules in the solution and retina respectively (the assumptions underlying the calculation are not universally accepted). It is shown that the delay in the recovery of the *b*-wave in the cat electroretinogram can be accounted for although the theory does not yet satisfy other temporal relations. R. A. WEALE

612.843.613

10692. Influence of the length in the perception "tests." M. SOLÍS AND M. AGUILAR. *An. Real. Soc. Españ. Fís. Quím.*, **50**, 89–94 (*March–April*, 1954) *In Spanish.*

The absolute form threshold T was measured as a function of the size of the test-field in three observers. The test-fields consisted of black rectangles on a white background, the angular length l and breadth b of the rectangles being variable. The eccentricity was 18° from the fovea. Monocular tests were done with and without fixation, binocular ones only with fixation. The binocular results showed that, for constant b, T decreased as $l \rightarrow 15°$ and remained constant for $15 < l < 30°$. In monocular vision, fixation led to higher thresholds than when the eye was free. There is a brief discussion of the significance of these results. 6 figs. are given. R. A. WEALE

612.85

10693. Note on the audibility of intense ultrasonic sound. B. H. DEATHERAGE, L. A. JEFFRESS AND H. C. BLODGETT. Letter in *J. Acoust. Soc. Amer.*, **26**, 582 (*July*, 1954).

The authors report that they heard a high-pitched tone when working in water in the beam of a transducer transmitting at 50 kc/s under conditions which indicated that the sound could only be heard by bone conduction. Evidence is given to support the view that the sound heard was a result of direct stimulation of the basal end of the cochlea and not vibration in the head in the sonic range of frequencies. The threshold at 50 kc/s obtained by holding a part of the jaw bone in contact with the surface of water in a bucket containing the transducer was about 2000 dynes/cm^2; that observed by a completely immersed swimmer was about 1000 dynes/cm^2. The threshold at 7 kc/s was about 12 dynes/cm^2, a figure agreeing with von Békésy's findings for bone conduction. H. J. H. STARKS

615.849.1

10694. Physical measurements of radiation through a grid. T. E. SOPP AND L. STANTON. *Amer. J. Roentgenol.*, **71**, 835–45 (*May*, 1954).

Measurements have been made of the dose distribution in a masonite phantom produced by a lead rubber grid having circular holes. The construction of a small ionization chamber for these measurements, of volume 0·03 ml, is described. Depth-dose data for 3 field sizes are presented. H. MILLER

TECHNICAL MATERIALS 66/67

666 : 539.23

Thin semiconducting layers on glass. *See Abstr.* 10557

PHOTOGRAPHY 77

77.021

10695. The preparation of ultra-fine grain photographic emulsions. B. H. CRAWFORD. *J. sci. Instrum.*, **31**, 333–5 (*Sept.*, 1954).

Work on the application of the Lippmann process of colour photography to the preparation of interference filters has resulted in a simple method of producing a range of fine-grain emulsions, some having a resolution exceeding 5000 lines per mm. A.

771.51 : 539.27

10696. Electron-microscopic observation of photographic emulsion. I. Appearance of the "halos" in electron micrographs. T. HIBI. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **4**, 545–52 (*Oct.*, 1952).

It was found that (1) the "halos" appeared with intense electron bombardment, (2) this was more remarkable when using the emulsions before sensitization in the dark room than after sensitization, (3) the ring pattern was clearer in the case of suddenly increasing an electron beam density than the case of slowly increasing it, and (4) the "halos" only appeared in the case of proper thickness of gelatine. A.

771.534

10697. A contribution to the theory of photographic sensitivity. J. W. MITCHELL. *J. photogr. Sci.*, **1**, 110–16 (*July–Aug.*, 1953).

A model for a micro-crystal of silver bromide in a chemically non-sensitized emulsion is proposed. Each crystal has a sub-structure consisting of a number of polyhedral blocks, slightly misaligned, the boundaries of which form intense local dislocations. The network of dislocations so formed is responsible for the localized separation of silver, and a high density region of dislocations constitutes the sensitivity centre of the crystal. The mechanism of the formation of the latent image is described on this model. Chemical sensitization is then explained by the adsorption of the sensitizer to the more active regions formed by the intersection of the dislocations and the surface of the crystal. Subsequently the sensitizer may spread over the rest of the surface. Its function is to trap the positive holes formed during exposure. Surface and internal latent image, and both high-intensity and low-intensity reciprocity failure are accounted for by this model. A.

771.534

10698. The photographic latent image. III. Dimensional changes in silver bromide following exposure. M. L. HUGGINS. *J. chem. Phys.*, **22**, 1389–96 (*Aug.*, 1954).

Using previously tested equations and constants, calculations are made of the dimensional changes to be expected in AgBr crystals as a result of the presence of varying proportions of uncharged bromine atom and silver-ion vacancy defects. The results depend to a considerable extent on the unknown degree of ordering of these defects. With reasonable assumptions as to this degree of ordering and as to the magnitudes of the other unknown and approximately known quantities involved, the experimentally observed behaviour—a lattice constant decrease, followed by a return to approximately the original value on further exposure—is quantitatively accounted for. A.

771.534.5

10699. The wedge spectrograph and the colour sensitivity of photographic plates and films. H. BÄCKSTRÖM. *Appl. sci. Res. B*, **4**, *No.* 1–2, 43–8 (1954).

By suitable filters, the light source can be made isoenergetic, and the spectrogram then shows directly the sensitivity to light as a function of the wavelength. A.

771.534.5 : 537.533

10700. The photographic effect of medium energy electrons. N. DIGBY, K. FIRTH AND R. J. HERCOCK. *J. photogr. Sci.*, **1**, 194–208 (*Nov.–Dec.*, 1953).

An E.M.3 Metropolitan-Vickers electron microscope was modified to enable the accelerating voltage and the current density falling on the photographic plate to be measured. This modified instrument was then used to investigate the response of a series of photographic materials, with accelerating voltages of 25 to 78 kV and current densities of 10^{-11} to 2×10^{-10} A/cm^2. Exposure times were in the range of 0·05 to 4·5 sec. The ratio of the speeds of the fastest to the slowest emulsion varied between 20 : 1 and 50 : 1 depending on the kilovoltage. For Nuclear Research B2 plates the D/E curve was linear over a wide range of densities and the photographic effect could be described by a simple linear equation connecting density, kilovoltage and exposure. Two of the other emulsions, Rapid Process Experimental and Thin Film Half Tone, also showed a linear D/E relationship near the origin. The slope of the linear portion of the Rapid Process Experimental curves was proportional to the accelerating voltage, but that of Thin Film Half Tone was not, possibly due to the loss of electrons from the rear of the emulsion. Photomechanical and Contact Lantern, the slowest materials, had "S" shaped D/E curves indicating the possibility of reciprocity failure. A.

771.535

10701. The depth of internal latent image. G. W. W. STEVENS. *J. photogr. Sci.*, **1**, 122–9 (*July–Aug.*, 1953).

The depth of the internal latent image within the grain has been estimated from measurement of the amount of silver halide which has to be removed to initiate internal development. Single-layer plates were used, so that all the grains would be equally accessible to the solution. This precaution should avoid the differential action occurring when silver halide solvents are applied to thick emulsion layers. With a "process" emulsion the depth was estimated at 60–100 Å (10–16 ion pairs), and similar results were obtained when cyanide or thiosulphate was used as solvent, or when ferricyanide was substituted for an acid dichromate bleach. With an X-ray emulsion the depth was estimated at 130–200 Å for an acid dichromate bleach, and 40 Å for a ferricyanide bleach. Bleaching in 10% chromic acid reduced the speed of the internal image by many hundreds of times, and the latent image so obtained was definitely

deeper (160 Å for process and 900 Å for X-ray emulsion). Removal of substantially greater amounts of silver halide before bleaching in acid dichromate, by contrast, still permitted an internal image of almost normal speed to develope. This indicates that the "deep" internal image left by 10% chromic acid is controlled by the processing method more than by emulsion properties. A.

771.535

10702. Estimation of the critical τ period in latent-image formation by intermittent exposures. R. E. MAERKER. *J. Opt. Soc. Amer.*, **44**, 625–9 (*Aug.*, 1954).

Low-intensity reciprocity-law failure in photographic exposure represents an inefficiency arising from the regression of the latent image in its early stages of growth. Evidence has been given to show that the stable sublatent image requires for its formation the action of two or more quanta in a small critical time period, τ. A new method for evaluating this critical time period by intermittent exposures is described. Experiments carried out on four commercial emulsions showed approximately equal τ periods of the order of 3 sec. Studies were also made on three experimental emulsions to determine the effect of certain types of chemical sensitization on the critical τ period. These experiments were carried out for both the surface and the internal latent image by means of varied development procedures. The critical τ period varied between 3 and 10 sec for the surface image and remained essentially constant at about 4 sec for the internal image. Results indicate that chemical sensitization increases the critical τ period of the surface latent image and slightly decreases the critical τ period of the internal image. A.

771.535 : 537.533.9

10703. Towards the theory of the photographic action of electrons. L. M. BIBERMAN AND I. A. KOVNER. *Zh. éksper. teor. Fiz.*, **26**, *No.* 2, 234–41 (1954) *In Russian.*

Obtains an expression for the probability of the formation of a latent image in a crystal of photoemulsion taking account of independent and of collective action by electrons passing through the crystal. The theoretical dependence of the density of blackening on the intensity of the electron beam for a constant number of electrons falling on a unit area of photoemulsion in the time of exposure qualitatively coincides with the result of experiment. W. BARDSLEY

771.535 : 548.7

10704. On the role of crystal imperfections in photographic sensitivity. J. W. MITCHELL. *Z. Phys.*, **138**, *No.* 3–4, 381–93 (1954).

The rôle of crystal imperfections in the formation of the latent image in large crystals of silver bromide has now been established by experimental work. The internal latent image is formed by the separation of silver along dislocation lines associated with strained regions of the crystal and with the boundaries of the polyhedral substructure. Chemical sensitizing agents are adsorbed and react preferentially at the surfaces of regions of strain and imperfection in the crystals. Non-reacting sensitizing molecules are also adsorbed in the same regions because of the higher density of kink sites associated with them. This means that the chemical sensitizers are concentrated at the surfaces of strained and imperfect parts of the crystal where positive holes and electrons liberated during exposure are most likely to be trapped. It is postulated that the trapping of the holes occurs before that of the electrons and leaves the surface with a positive charge due to an excess of silver ions. The bromine atoms formed by the trapping of the holes by bromide ions occupying kink sites combine with atoms or molecules of sensitizers. The silver ions ultimately attach themselves to nuclei consisting of one or two metallic atoms and these positively charged aggregates then combine with the electrons. In this way larger aggregates are formed which may become positively charged in equilibrium with the silver ions of the crystal and act as development centres. With some molecular sensitizers, it is possible that a surface latent image is produced by the internal rearrangement of the molecule without the actual liberation of electrons. A.

771.535 : 771.534.19

10705. The mechanism of the photographic pressure effect and its relation to latent image formation. P. FAELENS. *J. photogr. Sci.*, **2**, 105–12 (*May–June*, 1954).

Experiments revealed that desensitization of the total internal image at high intensity exposures has its origin in the fact that part of this total image behaves with respect to the pressure effect as a surface image. The deep internal image nevertheless always shows a sensitization by pressure. The appearance of a surface sensitization by pressure at very low intensities suggests that by pressure new electron traps are formed not only in the interior but also at the surface of the silver halide grains. The drop of surface desensitization by incubation of the pressed layer is explained as a recovery effect of the silver halide grains, whereas the increase of surface desensitization by incubation before pressure is ascribed to a softening of the silver halide crystals by a process analogous to that of annealing. A.

778.3 : 016 : 621.317.755

10706. Bibliography on high-speed photography including Schlieren and cathode-ray oscilloscope photography. *J. Soc. Motion Picture Televis. Engrs*, **61**, 749–57 (*Dec. I*, 1953).

Contains 210 references classified under the headings: general; cameras; lighting; oscillography; Schlieren; technical and techniques; X-ray.

778.34

10707. Determination of the mass of charged particles in nuclear emulsions by gap counting. G. KAYAS. *C.R. Acad. Sci.* [*Paris*] **238**, 2153–5 (*May* 31, 1954) *In French.*

The technique is described, and its precision is estimated with the aid of some experimental data.

J. J. WILKINS

778.34

10708. The role of pyrogallol in the development of nuclear emulsions. A. BONNET. Letter in *J. Phys. Radium*, **15**, 587–8 (*July–Aug.–Sept.*, 1954) *In French.*

A considerable improvement in uniform development of nuclear emulsions for thicknesses up to

400 μ can be obtained by using a pyrogallol-hydroquinone developer in place of the hydroquinone developer previously described, especially if the temperature cycle method is used. A. C. COATES

778.34

10709. Grain counting in nuclear emulsions. G. LOVERA. Letter in *Nuovo Cimento*, **12**, 154–5 (*July*, 1954) *In Italian.*

Statistical fluctuations in "grain" and "blob" counting on tracks in photographic emulsions are discussed. Experimentally, the mean square deviation is smaller than the square root of the mean value of the number of grains (or blobs) counted in equal lengths of the same track, in regions of approximately equal density. This justifies applying Bernoulli (rather than Poisson) statistics to the problem, and the expressions calculated for the mean square deviations show good numerical agreement with experimental data. P. ROTHWELL

778.6

10710. An objective method for determination of equivalent neutral densities of color film images. I. Definitions and basic concepts. W. L. BREWER AND F. C. WILLIAMS. *J. Opt. Soc. Amer.*, **44**, 460–4 (*June*, 1954).

A completely objective system for equivalent-neutral-density calibration of a set of photographic film images from a subtractive colour process is described. It includes these elements: (1) Restrictions on spectral density distributions of possible component absorbers are established by determining eigenvectors of the spectral density variability of images from the process. (2) Estimates of spectral density distributions of individual process dyes are adjusted to conformance with the restriction. (3) Spectral density distributions of process-formed grey images are predicted by combining spectral densities of actual process images with just-sufficient amounts of (two of) the conforming dyes; (4) Equivalent neutral densities of the third dye in the images are colorimetrically computed from the predicted grey-image distribution. A.

778.6

10711. An objective method for determination of equivalent neutral densities of color film images. II. Determination of primary equivalent neutral densities. R. H. MORRIS AND J. H. MORRISSEY. *J. Opt. Soc. Amer.*, **44**, 530–4 (*July*, 1954).

Numerical methods are presented for: (1) The determination of the spectral density distributions of the individual dyes of a subtractive photographic colour process. (2) The primary determination of the equivalent neutral densities of images formed by the subtractive colour process. A.

778.6

10712. An objective method for determination of equivalent neutral densities of color film images. III. Densitometer calibrations. F. H. HOLLAND, R. S. MICKELSON AND S. A. POWERS. *J. Opt. Soc. Amer.*, **44**, 534–9 (*July*, 1954).

Colour densitometers of certain types provide measurements which can be related to equivalent neutral densities of colour film dye images. The calibration of three types of densitometers suitable for routine use is described and the system is evaluated for (1) Accuracy of primary image calibration, and (2) Degree to which routine densitometer measurements conform to the primary values. Using this system, it has been possible to secure essentially identical equivalent neutral density values with different types of densitometers. A.